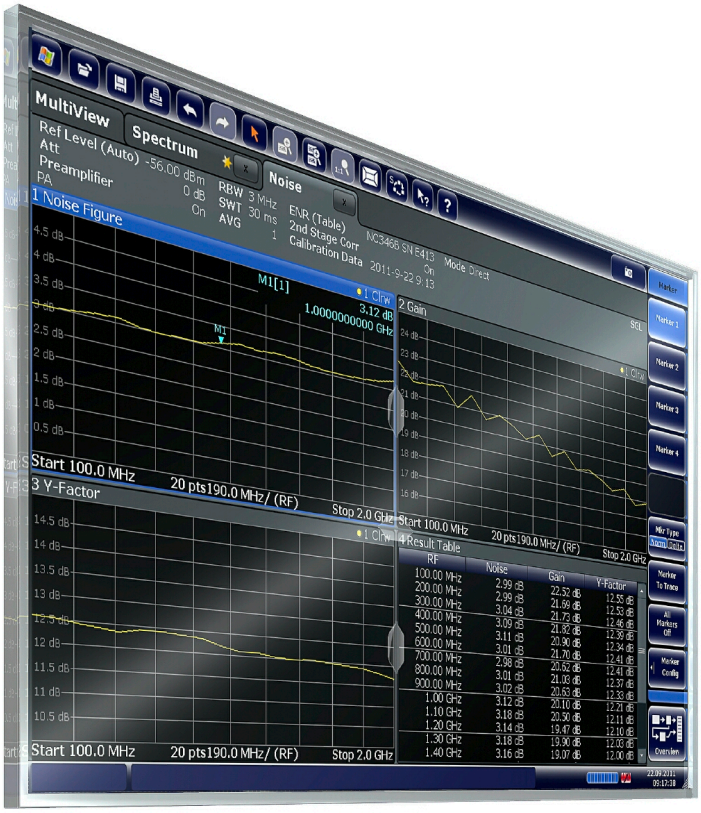
R&S®FSWP-K30
Noise Figure Measurements
User Manual



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Test & Measurement

User Manual

ROHDE&SCHWARZ

This manual describes the following R&S®FSWP models with firmware version 1.10 or higher:

- R&S®FSWP8 (1322.8003K08)
- R&S®FSWP26 (1322.8003K26)

The following firmware applications are described:

- R&S FSWP-K30 (1325.4244.02) (requires R&S FSWP-B1)

The software contained in this product makes use of several valuable open source software packages. For information, see the "Open Source Acknowledgment" on the user documentation CD-ROM (included in delivery).
Rohde & Schwarz would like to thank the open source community for their valuable contribution to embedded computing.

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The following abbreviations are used throughout this manual: R&S®FSWP is abbreviated as R&S FSWP. R&S MultiView is abbreviated as MultiView. Products of the R&S®SMW family, e.g. R&S®SMW200A, are abbreviated as R&S SMW.

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1 Preface

1.1 About this Manual

This User Manual provides all the information **specific to the application**. All general instrument functions and settings common to all applications and operating modes are described in the main R&S FSWP User Manual.

The main focus in this manual is on the measurement results and the tasks required to obtain them. The following topics are included:

- **Welcome to the Noise Figure Application**
  Introduction to and getting familiar with the application
- **Typical applications**
  Example measurement scenarios in which the application is frequently used.
- **Measurements and Result Displays**
  Details on supported measurements and their result types
- **Noise Figure Measurement Basics**
  Background information on basic terms and principles in the context of the measurement
- **Noise Figure Measurement Configuration + Analysis**
  A concise description of all functions and settings available to configure measurements and analyze results with their corresponding remote control command
- **How to Perform Measurements with the Noise Figure Application**
  The basic procedure to perform each measurement and step-by-step instructions for more complex tasks or alternative methods
- **Measurement Examples**
  Detailed measurement examples to guide you through typical measurement scenarios and allow you to try out the application immediately
- **Optimizing and Troubleshooting the Measurement**
  Hints and tips on how to handle errors and optimize the test setup
- **Remote Commands for Noise Figure Measurements**
  Remote commands required to configure and perform noise figure measurements in a remote environment, sorted by tasks
  (Commands required to set up the environment or to perform common tasks on the instrument are provided in the main R&S FSWP User Manual)
  Programming examples demonstrate the use of many commands and can usually be executed directly for test purposes
- **Annex**
  Reference material
- **List of remote commands**
  Alphahabetical list of all remote commands described in the manual
- **Index**

1.2 Documentation Overview

The user documentation for the R&S FSWP consists of the following parts:

- Printed Getting Started manual
- Online Help system on the instrument
- Documentation DVD with:
  - Getting Started
  - User Manuals for base unit and firmware applications
  - Service Manual
  - Release Notes
  - Data sheet and product brochures

Online Help

The Online Help is embedded in the instrument's firmware. It offers quick, context-sensitive access to the complete information needed for operation and programming. Online help is available using the icon on the toolbar of the R&S FSWP.

Getting Started

This manual is delivered with the instrument in printed form and in PDF format on the DVD. It provides the information needed to set up and start working with the instrument. Basic operations and handling are described. Safety information is also included.

User Manuals

User manuals are provided for the base unit and each additional (firmware) application.

The user manuals are available in PDF format - in printable form - on the Documentation DVD delivered with the instrument. In the user manuals, all instrument functions are described in detail. Furthermore, they provide a complete description of the remote control commands with programming examples.

The user manual for the base unit provides basic information on operating the R&S FSWP in general, and the Spectrum application in particular. Furthermore, the software functions that enhance the basic functionality for various applications are described here. An introduction to remote control is provided, as well as information on maintenance, instrument interfaces and troubleshooting.

In the individual application manuals, the specific instrument functions of the application are described in detail. For additional information on default settings and parameters, refer to the data sheets. Basic information on operating the R&S FSWP is not included in the application manuals.

Release Notes

The release notes describe the installation of the firmware, new and modified functions, eliminated problems, and last minute changes to the documentation. The corresponding firmware version is indicated on the title page of the release notes.

Application Notes

Application notes, application cards, white papers and educational notes are further publications that provide more comprehensive descriptions and background information. The latest versions are available for download from the Rohde & Schwarz website, at www.rohde-schwarz.com/appnote/.

1.3 Conventions Used in the Documentation

1.3.1 Typographical Conventions

The following text markers are used throughout this documentation:

Convention	Description
"Graphical user interface elements"	All names of graphical user interface elements on the screen, such as dialog boxes, menus, options, buttons, and softkeys are enclosed by quotation marks.
KEYS	Key names are written in capital letters.
`File names, commands, program code`	File names, commands, coding samples and screen output are distinguished by their font.
Input	Input to be entered by the user is displayed in italics.
Links	Links that you can click are displayed in blue font.
"References"	References to other parts of the documentation are enclosed by quotation marks.

1.3.2 Conventions for Procedure Descriptions

When describing how to operate the instrument, several alternative methods may be available to perform the same task. In this case, the procedure using the touchscreen is described. Any elements that can be activated by touching can also be clicked using an additionally connected mouse. The alternative procedure using the keys on the instrument or the on-screen keyboard is only described if it deviates from the standard operating procedures.

The term "select" may refer to any of the described methods, i.e. using a finger on the touchscreen, a mouse pointer in the display, or a key on the instrument or on a keyboard.

1.3.3 Notes on Screenshots

When describing the functions of the product, we use sample screenshots. These screenshots are meant to illustrate as much as possible of the provided functions and possible interdependencies between parameters.

The screenshots usually show a fully equipped product, that is: with all options installed. Thus, some functions shown in the screenshots may not be available in your particular product configuration.

2 Welcome to the Noise Figure Measurement Application

The R&S FSWP-K30 is a firmware application that adds functionality to perform noise figure measurements to the R&S FSWP.

Availability of Noise Figure Measurements

The Noise Figure Measurements application becomes available when you equip the R&S FSWP with the optional Spectrum Analyzer hardware (R&S FSWP-B1) and firmware application R&S FSWP-K30.

This user manual contains a description of the functionality that the application provides, including remote control operation.

Functions that are not discussed in this manual are the same as in the Spectrum application and are described in the R&S FSWP User Manual. The latest versions of the manuals are available for download at the product homepage.

http://www2.rohde-schwarz.com/product/FSWP.html.

Installation

Find detailed installing instructions in the Getting Started or the release notes of the R&S FSWP.

Noise Source Control

The Noise Source Control connector on the R&S FSWP is a prerequisite for the Noise measurement application.

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- Understanding the Display Information 12

2.1 Starting the Application

The noise figure measurement application adds a new type of measurement to the R&S FSWP.

To activate the Noise Figure application

1. Select the MODE key.

   A dialog box opens that contains all operating modes and applications currently available on your R&S FSWP.

2. Select the "Noise" item.

The R&S FSWP opens a new measurement channel for the noise figure measurement application.
All settings specific to noise figure measurements are in their default state.

Multiple Measurement Channels and Sequencer Function

When you enter an application, a new measurement channel is created which determines the measurement settings for that application. The same application can be activated with different measurement settings by creating several channels for the same application.

The number of channels that can be configured at the same time depends on the available memory on the instrument.

Only one measurement can be performed at any time, namely the one in the currently active channel. However, in order to perform the configured measurements consecutively, a Sequencer function is provided.

If activated, the measurements configured in the currently active channels are performed one after the other in the order of the tabs. The currently active measurement is indicated by a ⚙ symbol in the tab label. The result displays of the individual channels are updated in the tabs (as well as the "MultiView") as the measurements are performed. Sequential operation itself is independent of the currently *displayed* tab.

For details on the Sequencer function see the R&S FSWP User Manual.

2.2 Understanding the Display Information

The following figure shows the display as it looks for noise figure measurements. All different information areas are labeled. They are explained in more detail in the following sections.

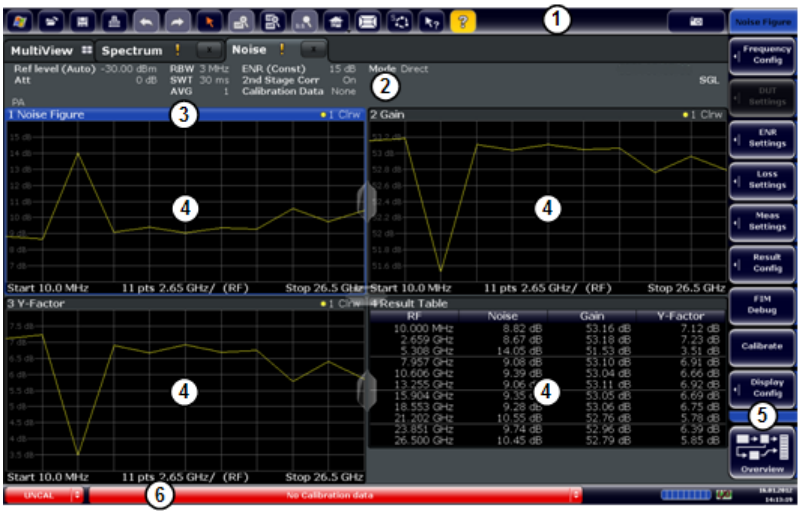


Fig. 2-1: Screen layout of the noise figure measurement application

1 = Toolbar
2 = Channel bar
3 = Diagram header
4 = Result display
5 = Softkey bar
6 = Status bar

Channel bar information

The channel bar contains information about the current measurement setup, progress and results.

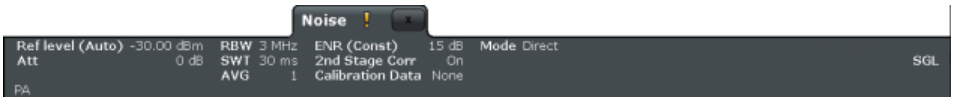


Fig. 2-2: Channel bar of the Noise Figure application

Ref Level	Reference level of the R&S FSWP.
Att	Attenuation of the R&S FSWP.
RBW	Resolution bandwidth
SWT	Sweep time
AVG	Number of averages
ENR	Excess noise ratio
2nd Stage Corr	State of the 2nd stage correction.
Calibration Data	Date and time of the current calibration data.
Mode	Currently selected measurement mode.

Window title bar information

For each diagram, the header provides the following information:

Fig. 2-3: Window title bar information for the Noise Figure application

1 = Window number
2 = Window type
3 = Trace color and number
4 = Trace mode

Status bar information

Global instrument settings, the instrument status and any irregularities are indicated in the status bar beneath the diagram. Furthermore, the progress of the current operation is displayed in the status bar.

NOTICE

Risk of damaging the instrument

Make sure not to overload the input mixer during calibration and the measurement. An overload condition may damage or destroy the input mixer.

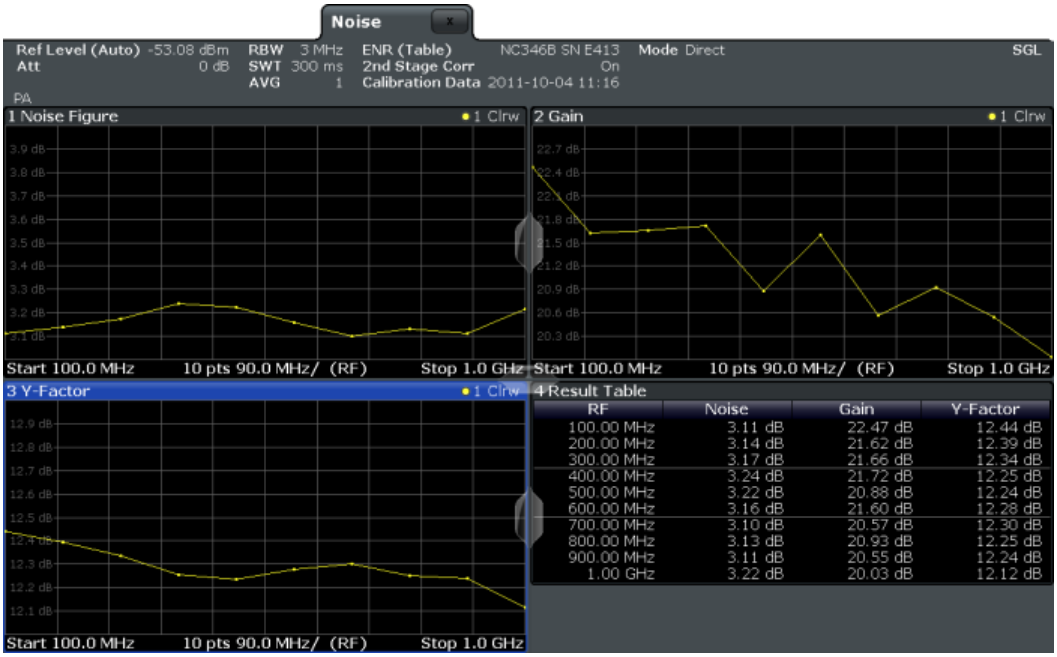
If an ocerload condition occurs, the R&S FSWP shows a corresponding message in the status line ("RF OVLD" or "IF OVLD").

To avoid an overload during calibration or measurement

- check and adjust the DUT gain settings,
- check and adjust the ENR settings
  or
- increase the reference level.

3 Measurements and Result Displays

The R&S FSWP-K30 measures the noise figure of a DUT and displays the results graphically and numerically. Each graphical result display shows the noise figure from a different perspective that may be relevant. In the default configuration, the application shows the Noise Figure of the DUT, the Gain of the DUT and the corresponding Y-Factor. In addition it shows the numerical results of the measurement.


Noise
Ref Level (Auto) -53.08 dBm
Att 0 dB
RBW 3 MHz
SWT 300 ms
AVG 1
ENR (Table)
2nd Stage Corr
Calibration Data 2011-10-04 11:16
NC346B SN E413
Mode Direct
SGL
PA
1 Noise Figure
1 Clrw
2 Gain
1 Clrw
Start 100.0 MHz
10 pts 90.0 MHz/ (RF)
Stop 1.0 GHz
3 Y-Factor
1 Clrw
4 Result Table
RF Noise Gain Y-Factor
100.00 MHz 3.11 dB 22.47 dB 12.44 dB
200.00 MHz 3.14 dB 21.62 dB 12.39 dB
300.00 MHz 3.17 dB 21.66 dB 12.34 dB
400.00 MHz 3.24 dB 21.72 dB 12.25 dB
500.00 MHz 3.22 dB 20.88 dB 12.24 dB
600.00 MHz 3.16 dB 21.60 dB 12.28 dB
700.00 MHz 3.10 dB 20.57 dB 12.30 dB
800.00 MHz 3.13 dB 20.93 dB 12.25 dB
900.00 MHz 3.11 dB 20.55 dB 12.24 dB
1.00 GHz 3.22 dB 20.03 dB 12.12 dB

The scale of the horizontal axis depends on the tuning mode.

Frequency list and swept measurements

In all graphical result displays, the horizontal axis represents the frequency. The displayed frequency is either the RF (radio frequency) or the IF (intermediate frequency). The range depends on the frequency set you have currently defined. Because the application only measures selected frequencies, it connects the results to draw a trace.

Negative noise figure and noise temperature

From a physical point of view, the noise figure and the noise temperature levels have a positive range (including zero).

Because of the mathematical operations the application performs, it may also show negative values in some cases. This may be due to incorrect calibration or variance of measurement values.

Single frequency measurements

In all graphical result displays, the horizontal axis represents a chronological order of measurement results for the frequency you are testing. The axis has no unit, but is made up out of several index values that represent time. Each index value represents

one measurement point and therefore one measurement on the single frequency you are analyzing. The size of the index (and thus number of results) depends on the number of (Measurement) Points that you have defined. Because the application only measures at certain points in time, it connects the results to draw a trace.

The right diagram border represents the present (index = 0), values to the left represent past measurement results (index = -<x>). As soon as the application finishes a single measurement, the measurement points are moved to the left, the new result is added on the right. All other measurement points are moved down one position with the most obsolete result falling out of the diagram (like in the roll mode of an oscilloscope).

Selecting the result display

► Select the icon in the toolbar or press the MEAS key.

The application enters the SmartGrid configuration mode.
For more information on the SmartGrid functionality see the R&S FSWP Getting Started.

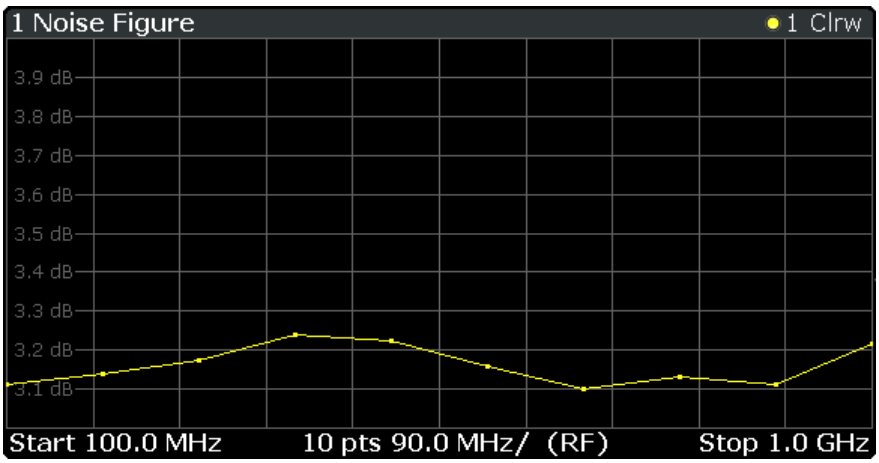
Noise Figure....16
Gain....17
Noise Temperature....17
Y-Factor....18
Power (Hot)....19
Power (Cold)....19
Cal Y-Factor....20
Cal Power (Hot)....21
Cal Power (Cold)....21
Result Table....21
Current Values....22
Marker Table....22

Noise Figure
Shows the noise figure of the DUT.

The noise figure is the ratio of the signal-to-noise ratio at the DUT input to that at the DUT output.

$$\text{Noise Figure} = \frac{SNR_{in}}{SNR_{out}}$$

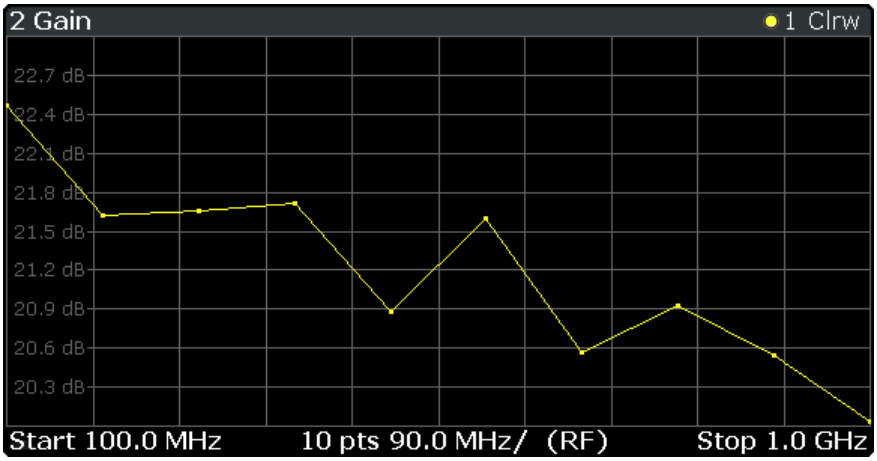
The vertical axis shows the level of the noise figure in dB. The scale depends on the settings in the "Display Configuration" dialog box.



Remote command:
`LAY:ADD:WIND '2',RIGH,NOIS` see `LAYout:ADD[:WINDow]?` on page 98
Results:
TRACe<t>[:DATA] NFIGure

Gain
Shows the gain characteristics of the DUT.

The vertical axis shows the level of the gain in dB. The scale depends on the settings in the "Display Configuration" dialog box.



Remote command:
`LAY:ADD:WIND '2',RIGH,GAIN` see `LAYout:ADD[:WINDow]?` on page 98
Results:
TRACe<t>[:DATA] GAIN

Noise Temperature
Shows the noise temperature characteristics of the DUT.

$$\text{Noise Temperature} = \frac{P}{B \cdot k}$$

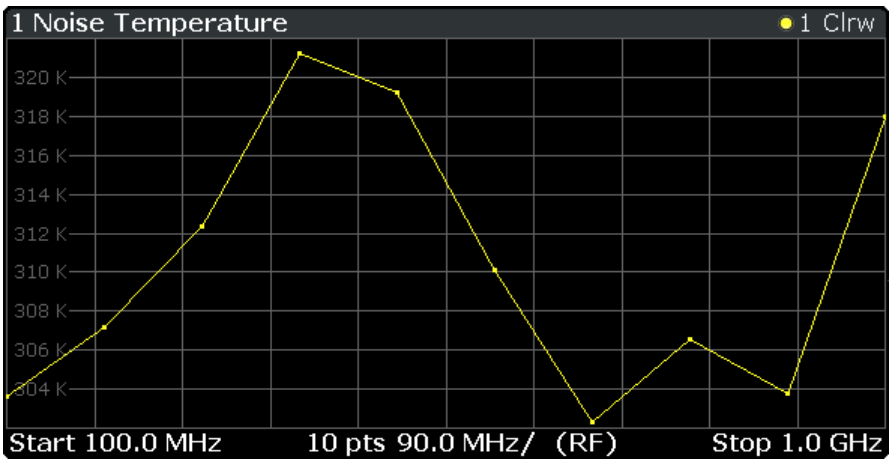
with

P = Power

B = Bandwidth

k = Boltzmann constant

The vertical axis shows the noise temperature in Kelvin. The scale depends on the settings in the "Display Configuration" dialog box.



Remote command:

`LAY:ADD:WIND '2',RIGH,TEMP` see `LAYout:ADD[:WINDow]?` on page 98

Results:

TRACe<t>[:DATA] TEMPerature

Y-Factor

Shows the ratio of the hot and the cold power of the DUT.

The Y-factor indicates the quality of measurement tolerances and uncertainties. To get the result, the application measures the DUT power with the noise source turned on (hot power) and the noise source turned off (cold power).

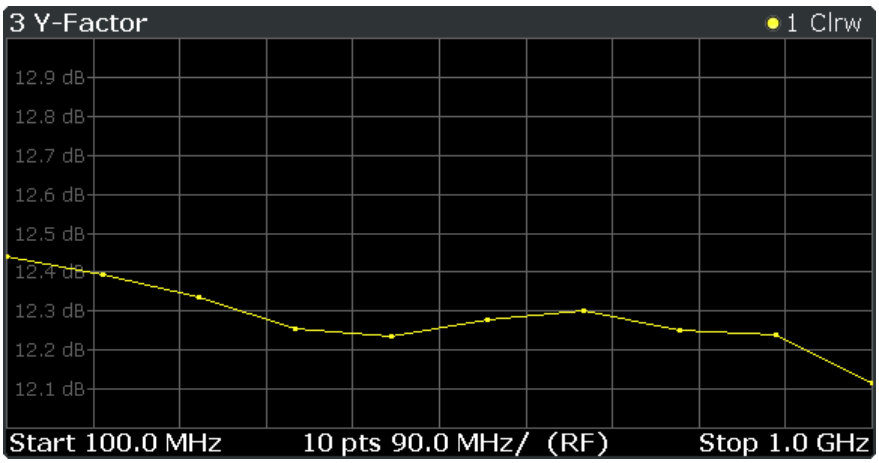
$$\text{Y-Factor} = \frac{N_{on}}{N_{off}}$$

with

N_{on} = Noise power [dB] with noise source on

N_{off} = Noise power [dB] with noise source off

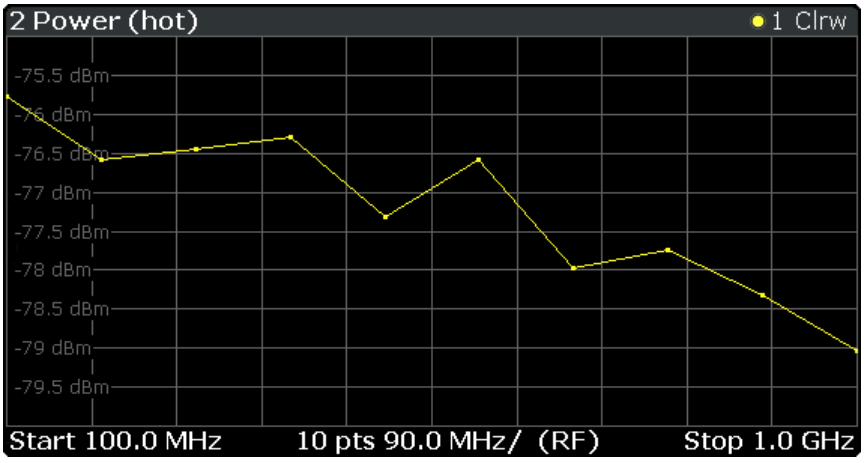
The vertical axis shows the linear relation. The scale depends on the settings in the "Display Configuration" dialog box.



Remote command:
`LAY:ADD:WIND '2',RIGH,YFAC` see `LAYout:ADD[:WINDow]?` on page 98
Results:
TRACe<t>[:DATA] YFACtor

Power (Hot)
Shows the absolute power characteristics at the instrument input. The noise source is turned on.

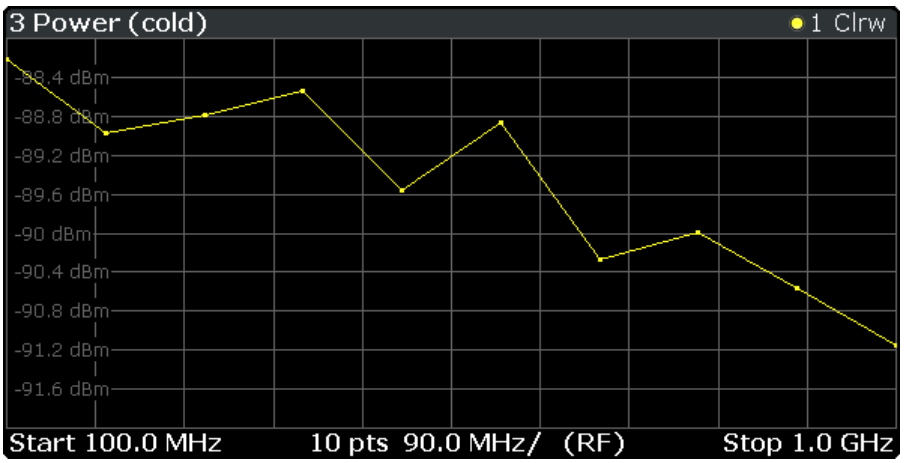
The vertical axis shows the power in dBm. The scale depends on the settings in the "Display Configuration" dialog box.



Remote command:
`LAY:ADD:WIND '2',RIGH,PHOT` see `LAYout:ADD[:WINDow]?` on page 98
Results:
TRACe<t>[:DATA] PHOT

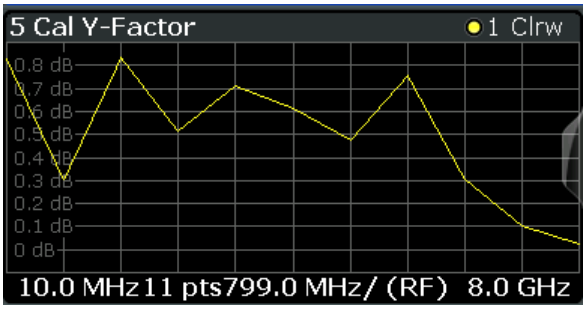
Power (Cold)
Shows the absolute power characteristics at the instrument input. The noise source is turned off.

The vertical axis shows the power in dBm. The scale depends on the settings in the "Display Configuration" dialog box.



Remote command:
`LAY:ADD:WIND '2',RIGH,PCOL` see `LAYout:ADD[:WINDow]?` on page 98
Results:
TRACe<t>[:DATA] PCOLd

Cal Y-Factor
Shows the ratio of the hot and the cold power measured during calibration.



The Y-factor indicates the quality of measurement tolerances and uncertainties. To get the result, the application measures the power with the noise source turned on (hot power) and the noise source turned off (cold power), but without the DUT inserted.

$$\text{Y}-\text{Factor} = \frac{N_{on}}{N_{off}}$$

with

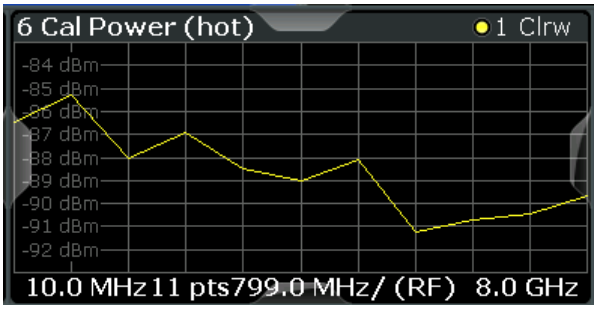
N_{on} = Noise power [dB] with noise source on

N_{off} = Noise power [dB] with noise source off

The vertical axis shows the linear relation. The scale depends on the settings in the "Display Configuration" dialog box.

Remote command:
`LAY:ADD:WIND '2',RIGH,CYF` see `LAYout:ADD[:WINDow]?` on page 98
Results:
TRACe<t>[:DATA] CYFactor

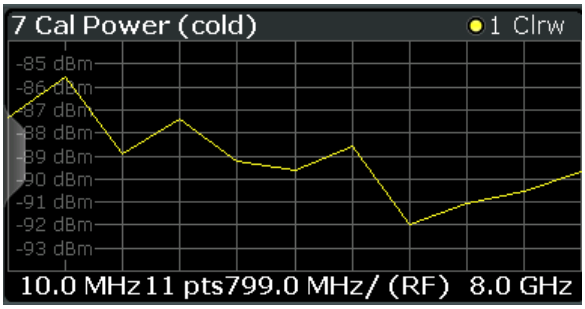
Cal Power (Hot)
Shows the absolute power characteristics at the instrument input during the calibration measurement. The noise source is turned on, the DUT is not inserted.



The vertical axis shows the power in dBm. The scale depends on the settings in the "Display Configuration" dialog box.

Remote command:
`LAY:ADD:WIND '2',RIGH,CPH` see `LAYout:ADD[:WINDow]?` on page 98
Results:
TRACe<t>[:DATA] CPHot

Cal Power (Cold)
Shows the absolute power characteristics at the instrument input during the calibration measurement. The noise source is turned off, the DUT is not inserted.



The vertical axis shows the power in dBm. The scale depends on the settings in the "Display Configuration" dialog box.

Remote command:
`LAY:ADD:WIND '2',RIGH,CPC` see `LAYout:ADD[:WINDow]?` on page 98
Results:
TRACe<t>[:DATA] CPCold

Result Table
Shows the measurement results in numerical form in a table.

The contents of the table depend on the "Display Settings". By default it shows the results for the Noise Figure, Gain and Y-Factor result type. Each row represents one measurement point. Each column represents one result type. The first column shows the measurement frequency.

If you display the uncertainty result, it is displayed in the Noise column next to the Noise Figure result. Note that the uncertainty is displayed only after you have turned on the uncertainty calculation and also include the result in the display.

The result table shows either the RF or the IF, depending on you selection.

For more information see chapter 6.1.2, "Configuring Numerical Results", on page 77.

4 Result Table

RF	Noise	Gain	Y-Factor
100.00 MHz	3.11 dB	22.47 dB	12.44 dB
200.00 MHz	3.14 dB	21.62 dB	12.39 dB
300.00 MHz	3.17 dB	21.66 dB	12.34 dB
400.00 MHz	3.24 dB	21.72 dB	12.25 dB
500.00 MHz	3.22 dB	20.88 dB	12.24 dB
600.00 MHz	3.16 dB	21.60 dB	12.28 dB
700.00 MHz	3.10 dB	20.57 dB	12.30 dB
800.00 MHz	3.13 dB	20.93 dB	12.25 dB
900.00 MHz	3.11 dB	20.55 dB	12.24 dB
1.00 GHz	3.22 dB	20.03 dB	12.12 dB

Remote command:
`LAY:ADD:WIND '2',RIGH,RES` see `LAYout:ADD[:WINDow]?` on page 98
Results:
`TRACe<n>[:DATA]?` on page 105

Current Values
Shows the result at the current measurement point.

The contents of the "Current" result display are updated as soon as a new measurement point is analyzed.

The result types shown in the table depend on the "Display Settings". By default it shows the results for the Noise Figure, Gain and Y-Factor result type. Each row represents one result type. The first column shows the result type, the second column shows the result.

For more information see chapter 6.1.2, "Configuring Numerical Results", on page 77.

Marker Table
Shows the marker characteristics in numerical form in a table.

The size of the table depends on the number of active markers and the way you have configured the table in the "Result Config" dialog box. For more information see chapter 6.3, "Using Markers", on page 79 and chapter 6.1.2, "Configuring Numerical Results", on page 77.

4 Marker Table

Type	Ref	Trc	Stimulus	Noise	Gain
N1		1	400.00 MHz	3.24 dB	21.72 dB
D2	N1	1	100.00 MHz	-0.01 dB	-0.84 dB
D3	N1	1	200.00 MHz	-0.08 dB	-0.12 dB

The first four columns of the table are fix.

- Type
  Shows the marker type. 'M' represents a normal marker, 'D' represents a delta marker.
- Ref
  Shows the reference marker for relative delta markers.

- Trc
  Shows the trace the marker is positioned on.
- X-value
  Shows the horizontal position (frequency) of the marker.
  In case of normal markers, the position is an absolute value. The position of delta markers are relative to another marker.
- <Result>
  Shows the measurement result at the marker position.
  In case of normal markers, the result is an absolute value. Results for delta markers are relative to another marker.

Remote command:
`LAY:ADD:WIND '2',RIGH,MTAB` see `LAYout:ADD[:WINDow]?` on page 98
Results:
`CALCulate<n>:MARKer<m>:Y?` on page 162
`CALCulate<n>:DELTamarker<m>:Y?` on page 164

4 Measurement Basics

The measurement basics contain background information on the terminology and principles of noise measurements.

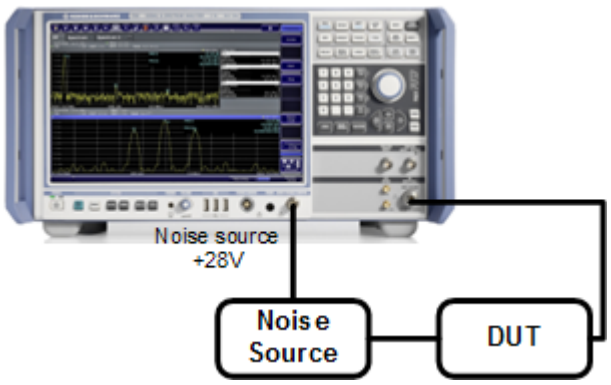
Noise figure measurements determine the noise that a device under test (DUT) adds to a signal as that signal passes through the DUT.

- Tuning Modes 24
- Measurement Modes 26
- DUT Types 28
- External Generator Control 29
- Image Frequency Rejection 31
- Calibration (2nd Stage Correction) 33
- Separating Signals by Selecting an Appropriate Resolution Bandwidth 36
- Analyzing Several Traces - Trace Mode 36
- Using Markers 37

4.1 Tuning Modes

Basically, the application calculates the noise figure of a DUT based on the characteristics of the DUT that have been measured and a noise source whose properties are known. Therefore, the Noise Source Control connector on the R&S FSWP is a prerequisite for the Noise measurement application.

In addition to the noise characteristics of a DUT, the application is also able to determine several more DUT characteristics like its gain or its noise temperature characteristics.



The application provides several measurement modes or **tuning modes**.

- Swept Measurements 25
- Frequency Table Measurements 25
- Single Frequency Measurements 25

4.1.1 Swept Measurements

The **sweep** tuning mode performs measurements on a set of discrete frequencies based on the frequency parameters. Each measurement analyzes the noise characteristics of the corresponding frequency or measurement point.

For swept measurements, the application automatically determines the measurement frequencies and combines them in a frequency list.

Such a frequency set is the result of the frequency and span information that you have provided. The frequency and span information is made up out of the center frequency, the span, the start and the stop frequency. In combination with the measurement points or the frequency table step size, the application calculates the contents of the frequency table.

The **center frequency** is the frequency in the center of the frequency band you are measuring. Thus, it is defined either by the span or the start and stop frequencies.

The **measurement points** is the number of entries in a frequency list and thus the number of measurements that the application performs during a noise figure measurement.

The **stepsize** defines the distance between two measurement points. It is constant for all measurement points.

If the stepsize is larger than the distance between start and stop frequency, the frequency table consists of the start and stop frequencies only.

4.1.2 Frequency Table Measurements

The **frequency table** tuning mode also performs measurements on a set of frequencies based on the contents of a frequency list. Each measurement analyzes the noise characteristics of the corresponding frequency.

Compared to a swept measurement, you can customize the contents of the frequency list. Thus, you can add frequencies that are independent of the frequency stepsize and the number of measurement points.

4.1.3 Single Frequency Measurements

The **single frequency** tuning mode performs one or several consecutive measurements on a single frequency. You can perform the measurement on any frequency that is supported by the hardware you are using.

Single frequency measurements are a way to facilitate manual adjustments for noise figure measurements. They also allow you to get an idea about how the noise figure at a particular frequency change over time.

Note that sweep lists or frequency tables are not considered in this measurement mode.

Single frequency measurement results

For single frequency measurements, the same set of graphical result displays is available as for frequency list measurements (Noise Figure, Gain etc.). Note, however, that the x-axis has no unit, but shows a series of results taken for a single frequency. The number of displayed results depends on the number of measurement points you have defined.

For more information see chapter 3, "Measurements and Result Displays", on page 15.

In addition, you can also view the results in the Result Table in numerical form.

Single frequency measurements are not available when you are using a resistor as a noise source.

4.2 Measurement Modes

In some cases, the Power (Hot) and Power (Cold) results require two different noise sources with different temperature characteristics (cold and hot). An example are measurements with a resistor that is used as a noise source.

Usually, noise sources with diode characteristics are used for Noise Figure measurements. These noise sources have two states, on and off. When they are supplied with power (state = on), the application measures the hot power, when they are not supplied with power (state = off), it measures the cold power. Turning the noise source on and off is automatically done by the application, so that you can get the hot and cold power characteristics in a single step.

This **automatic measurement mode** is the default measurement mode of the Noise Figure Measurements application.

When you are using resistor as a noise source, however, this is not possible, because two resistors, one hot and one cold, are required, and you have to substitute the hot resistor with the cold resistor to measure the hot and cold power respectively. For these cases, the application provides a **manual measurement mode**. This measurement mode is automatically selected when you select a noise source with resistor characteristics, but is not restricted to those cases.

The manual measurement mode is available for measurements and the calibration stage.

Performing a manual measurement

In manual measurement mode, you have to measure (or calibrate) the hot an cold power characteristics of the DUT separately. When you start the measurement, the application opens a dialog box that allows you to select the type of measurement to perform next.

Recommended order of measurements

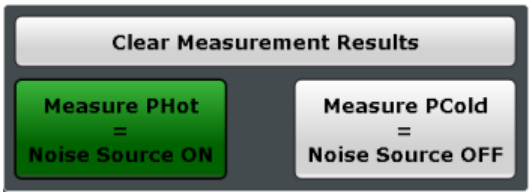
Note that it is recommended, and in case of uncalibrated measurements required, to begin with the hot power measurement.

Furthermore, calibration always begins with the hot power measurement.

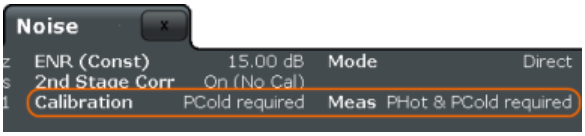
In case the hot power has to be measured first, the cold power measurement is unavailable:

When the first measurement is done, you can change the test setup by connecting the other resistor and start the seconds measurement (hot or cold, depending on which measurement you have done first).

In the dialog box, the measurement stage that is already done is labeled green.



In addition, the application shows the missing calibration and measurement steps in the channel bar.



Clearing results

If you have to replace the previous calibration or measurement results, you can clear the currently stored data with the "Clear Calibration Results" or "Clear Measurement Results" button that is also available in the dialog box.

Returning to automatic measurement mode

When you are in automatic measurement mode and select a noise source with resistor characteristics, the application automatically selects the manual measurement mode.

When you are in manual measurement mode and select a noise source with diode characteristics, you have to select the automatic measurement mode deliberately in the "Sweep" menu.

4.3 DUT Types

Noise figure measurements are possible on DUTs with a wide variety of characteristics. The DUT characteristics are important to know because they not only have an effect on the test setup, but also determine the way the application populates the frequency list in case of swept measurements.

The Noise Figure Measurements application supports measurements on DUTs that work on a fixed frequency as well as measurements on frequency-converting DUTs.

- Measurements on Linear DUTs 28
- Measurements on Frequency Converting DUTs 28

4.3.1 Measurements on Linear DUTs

In case of a linear DUT, the RF frequency remains the same between its input and output. For measurements on such DUTs, it is sufficient to measure the signal's RF frequency without any additional equipment (like a local oscillator). A typical linear DUT is, for example, an amplifier.

The test setup for measurements on such DUTs usually consists of the noise source, the DUT and an analyzer. If necessary, the measurement also considers loss that might occur somewhere in the measurement path.

If you are measuring linear DUTs, the contents and layout of the "Overview" dialog box represents the configuration of a typical test setup.

4.3.2 Measurements on Frequency Converting DUTs

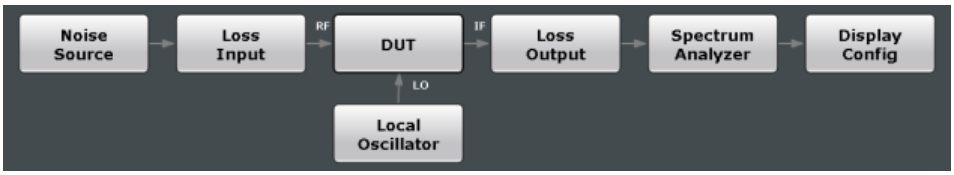
A frequency converting DUT converts the RF frequency to an intermediate frequency (IF) using the local oscillator (LO). A frequency-converting DUT either converts the RF frequency to a lower IF (down-conversion) or a higher IF (up-conversion).

The conversion process requires a local oscillator in the test setup. You can generate the LO signal in two ways.

- An external generator controlled by the analyzer via IEC bus.

- A VCO controlled by a voltage source.

If you have selected a frequency-converting DUT measurement mode, the layout of the "Overview" dialog box adds the local oscillator to the test setup.



The local oscillator can have a fixed or a variable frequency. If the LO frequency is fixed, the intermediate frequency (IF) resulting from the conversion process is variable (depending on the input signal). If the LO frequency is variable, the IF has to be fixed. The application provides measurement for both measurement scenarios.

Fixed intermediate frequency

If you select one of the fixed IF measurement modes, the IF is the same for all entries in the frequency list. The LO frequency for each entry is variable and is the result of the equation the selected mode is based on.

- $f_{RF} - f_{IF}$ for up-converters
- $f_{RF} + f_{IF}$ for down-converters

The fixed IF measurement modes are, for example, useful for measurements on mixers.

Note that fixed IF measurements are only possible if the R&S FSWP is equipped with the optional External Generator Control hardware. For more information see chapter 4.4, "External Generator Control", on page 29.

Fixed LO frequency

If you select one of the fixed LO measurement modes, the LO frequency is the same for all entries in the frequency list. The IF frequency for each entry is variable and is the result of the equation the selected mode is based on.

- $f_{RF} + f_{LO}$ for up-converters
- $f_{RF} - f_{LO}$ for down-converters

The fixed LO measurement modes are, for example, required for measurements on satellite converters.

4.4 External Generator Control

To perform fixed IF measurements with the Noise Figure application, you have to install the optional External Generator Control hardware. This option allows you to control an external generator and the type of signal it generates.

The typical measurement setup for such measurements includes the R&S FSWP equipped with the optional Noise Figure Measurements application, a signal generator

and the DUT. The signal generator is controlled either via the the LAN connection or the GPIB interface. The GPIB interface is part of the optional External Generator Control hardware.

To enhance the measurement accuracy, it is recommended to use a common reference frequency for both R&S FSWP and signal generator in the measurement setup.

If you have no 10 MHz reference frequency on hand, you can use the internal reference signal of the R&S FSWP or signal generator. For more information see the documentation of the R&S FSWP or the signal generator.

Signal generator support

The R&S FSWP-B10 supports various signal generators. A list is available in the user interface (see Generator Type) and in the documentation of the R&S FSWP.

Note that you have to specifically select the generator for the Noise Figure Measurements application. It does not inherit the generator settings from other applications.

It is also possible to add new signal generators to that list. To do so, you have to copy a custom signal generator setup file with the file extension `.gen` to the R&S FSWP. The setup file defines the frequency and power ranges supported by the generator, as well as information required for communication. You can use a setup file of the signal generators already supported as a template. After you copy it to the R&S FSWP, the new generator model is added to the dropdown menu.

The existing setup files can be displayed in an editor in read-only mode directly from the Interface Configuration dialog box.

Make sure to adhere to the required syntax and commands and only change the values of the parameters. Errors are only detected and displayed when you try to use the custom generator.

Error and status messages

The following status and error messages may occur during external generator control.

Message	Description
"Ext. Generator GPIB Handshake Error!" / "Ext. Generator TCPIP Handshake Error!" / "Ext. Generator TTL Handshake Error!"	Connection to the generator is not possible, e.g. due to a cable damage or loose connection or wrong address.
"Ext. Generator Limits Exceeded!"	The allowed frequency or power ranges for the generator were exceeded.
"Reverse Sweep via min. Ext. Generator Frequency!"	Reverse sweep is performed; frequencies are reduced to the minimum frequency, then increased again.
"Ext. Generator File Syntax Error!"	Syntax error in the generator setup file.
"Ext. Generator Command Error!"	Missing or wrong command in the generator setup file.
"Ext. Generator Visa Error!!"	Error with Visa driver provided with installation (very unlikely).

NOTICE

Risk of damage to the instrument

For yielding highest sensitivity during the measurement, the Noise Figure Measurements application automatically sets the input attenuation to 0 dB.

Because this configuration minimizes the overrange reserve, make sure that the signal you have applied does not cause to an overload condition (pay attention to the LO feedthough). An overload condition may damage or destroy the input mixer.

The R&S FSWP shows a corresponding message in the status line if an overload occurs ("RF OVLD" or "IF OVLD").

To avoid an overload

- reduce the LO feedthrough of the mixer device
  or
- increase the reference level.

4.5 Image Frequency Rejection

Frequency converting DUTs convert a radio frequency (RF) to an intermediate frequency (IF). The IF is lower than the RF in case of down-converting DUTs and higher than the RF in case of up-converting DUTs.

In a basic test setup, the image frequency of the RF signal is also converted to the IF. Depending on the DUT, this effect may be wanted or even necessary, or not. To avoid measurement errors of the noise figure and gain of up to 3 dB, make sure to use the appropriate measurement configuration.

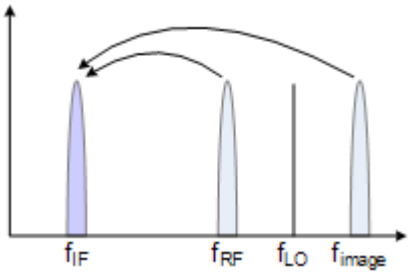
Basically, you can distinguish between single sideband (SSB) mixers and double sideband (DSB) mixers or those that partly suppress a sideband. If a sideband is not needed or only partly needed, you can reject the image frequency. If you do so, the application activates a filter that suppresses the image frequency to a certain extent.

The following illustrations help you to configure the measurement in order to measure correctly.

For more information on how to configure image rejection see "Image Rejection" on page 49.

Double sideband measurements

Double sideband mixers use both sidebands to the same extent. Both RF and image frequency should be converted. In that case, you have to turn image rejection off.

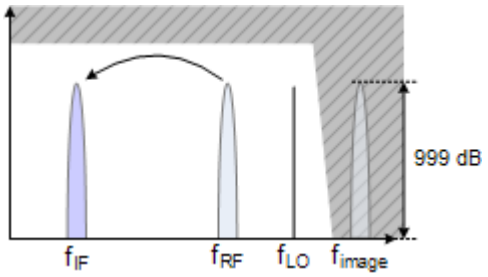


f_{LO} = frequency of the local oscillator
f_{IF} = intermediate frequency = $f_{RF} \pm f_{LO}$
f_{RF} = lower sideband = $f_{LO} - f_{IF}$
f_{image} = upper sideband = $f_{LO} + f_{IF}$

If image rejection is on, the results have a 3 dB error - noise figure results are 3 dB lower than they should be, gain results are 3 dB higher than in reality.

Single sideband measurements

Single sideband mixers use a single sideband only. In that case, you have to suppress the sideband that is not required. If you do so, the measurement is pretty straightforward and works like a measurement on an amplifier.

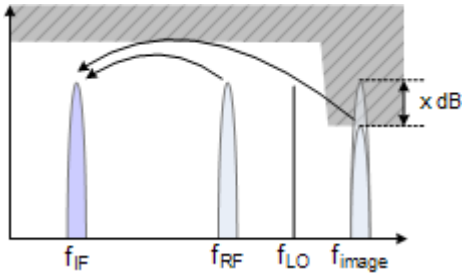


To suppress a sideband completely, it is best to set the image rejection to the maximum amount possible (999.99 dB).

Partial sideband suppression

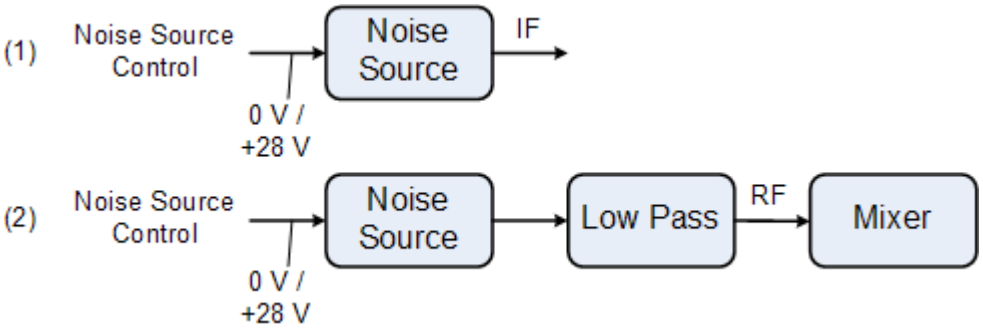
For measurements on mixers with a low image frequency rejection, there are two test scenarios.

- Mixers whose image rejection is known.
- Mixers whose image rejection is unknown.



In case of mixers whose image rejection is known, define the magnitude of image rejection in dB as accurate as possible. Else, measurement results (noise figure and gain) will deviate between 0 dB to 3 dB.

For accurate measurements on mixers whose image rejection characteristics are unkown a custom test setup including an additional filter is required. You also have to know the gain characteristics of the DUT.



(1) = Test setup for calibration
(2) = Test setup for noise measurement

In the test setup shown above, a lowpass filter prevents unwanted noise from being fed in at the image frequency.

Depending on the position of the frequency bands, a highpass or bandpass filter may also be necessary for the RF frequency instead of the lowpass filter. The important point is that unwanted noise is not converted by a further receive path of the mixer. The unwanted noise at the receive frequency must not be reduced. The insertion loss must be considered, if applicable.

With this test setup, the measurement on a mixer without sideband suppression is the same as SSB measurements.

To take the characteristics of the filter into account, include the insertion loss of the filter at the RF. To consider the actual filter suppression at the image frequency, include the actual attenuation for the image rejection.

Harmonics mixer measurement

For a harmonics mixer, the input signals are not only converted to the IF by the wanted harmonic, but also by the harmonic of the LO signal produced in the mixer. In many cases, the mixer even features a lower conversion loss in the case of unwanted harmonics. For measurements on this type of mixer, you have to use a bandpass filter to make sure that that there is only noise at the desired input frequency at the input of the DUT. This measurement is similar to measurements on a mixer with an average sideband suppression.

4.6 Calibration (2nd Stage Correction)

The calibration procedure of the application measures the inherent noise of the R&S FSWP you are using. Performing calibration therefore is recommended as it increases the accuracy of measurement results. The results get more accurate

because the application takes the inherent noise of the analyzer into account while it calculates the results.

Calibration for noise figure measurements is also known as 2nd stage correction. This term is used because in a typical noise figure test setup, the DUT represents the first stage and the analyzer the second stage in the test setup.

The 2nd stage correction is a calibration that is specific to noise figure measurements. It is independent of the overall calibration state of the analyzer and does not calibrate the analyzer.

For successful calibration, you need additional equipment.

- Noise source
  The noise source is like a calibration standard. It provides a reference with known noise characteristics that allows the application to determine the inherent noise of the analyzer you are using.

During the calibration, the application measures the inherent noise characteristics of the analyzer at the set of measurement frequencies.

Thus, the 2nd stage correction is valid for a particular instrument configuration, the room temperature and the instrument temperature. As long as this configuration stays the same, calibration data remains valid.

Calibrating single frequency measurements

Like all other measurements of the Noise Figure application, single frequency measurements should be performed in a calibrated state for increased accuracy.

Note that there is an easy way to calibrate single frequency measurements, if you have calibrated the application for swept or list measurements and the single frequency is part of the frequency list. In that case the measurement is already calibrated for that frequency and no more steps are necessary. The application recalls the last calibration values when you switch back to sweep mode or frequency table mode.

Only if you use a single frequency that is not part of the frequency list (or use a completely different frequency outside the calibrated range) will calibration become invalid and you should calibrate this frequency point.

- Interpolation
  If you change the frequency and the frequency span stays the same or gets smaller, the application interpolates the correction data for the new measurement points instead of requesting a new calibration.
  Measurements based on interpolated data might result in an increased measurement uncertainty. Highly accurate measurements that are conform to the values specified in the data sheet are only possible at calibrated measurement points.
  Note that useful interpolation is possible only if essential calibration parameters (e.g. impedance or attenuation) change only slightly. This is the case if the distance between the original calibration points has been sufficiently small.
  If the span increases compared to the span during calibration, a new calibration is necessary.

If the application interpolates the caibration data, it shows a corresponding label in the channel bar and a warning message in the status bar.

- Invalid calibration
  If you change one of the amplitude parameters (e.g. the attenuation), calibration is labeled invalid. In that case, calibration is not accurate, because the settings are not in line with the settings at the time the R&S FSWP has been calibrated. If calibration is invalid, repeat the calibration or restore the settings as they were during the calibration.

Saving calibration data

If you save the current configuration or measurement results to a data set, calibration data is part of that data set.

For more information on saving and restoring data sets see chapter "Storing and Recalling Instrument Settings and Measurement Data" in the user manual of the R&S FSWP.

The picture below shows a typical calibration setup that includes a noise source.

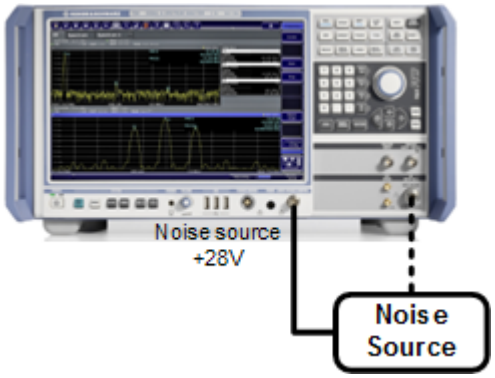


Fig. 4-1: Noise figure calibration setup

1. Connect the noise source directly and without a cable to the RF input of the analyzer.
2. Connect the noise source to the +28 V voltage supply (Noise Source interface) on the back of the R&S FSWP.
   To connect the noise source to the voltage supply, you need a coaxial cable.

After you have set up calibration, there are several ways to start calibration.

- In the "Noise Overview" dialog box, press the "Calibrate" button.
- In the "Sweep" menu, press the "Calibrate" softkey.

4.7 Separating Signals by Selecting an Appropriate Resolution Bandwidth

The resolution bandwidth defines the 3 dB bandwidth of the resolution filter to be used. An RF sinusoidal signal is displayed according to the passband characteristic of the resolution filter (RBW), i.e. the signal display reflects the shape of the filter.

The highest sensitivity is obtained at the smallest bandwidth (1 Hz). If the bandwidth is increased, the reduction in sensitivity is proportional to the change in bandwidth. Increasing the bandwidth by a factor of 3 increases the displayed noise by approx. 5 dB (4.77 dB precisely). If the bandwidth is increased by a factor of 10, the displayed noise increases by a factor of 10, i.e. 10 dB.

The higher spectral resolution with smaller bandwidths is won by longer sweep times for the same span. The sweep time has to allow the resolution filters to settle during a sweep at all signal levels and frequencies to be displayed.

If the RBW is too large, signal parts that are very far away (e.g. from a different signal) are considered in the measurement and distort the results. The displayed noise increases.

If the RBW is too small, the measurement time increases.

4.8 Analyzing Several Traces - Trace Mode

The trace mode determines the way the data is processed and displayed. The application provides the following trace modes.

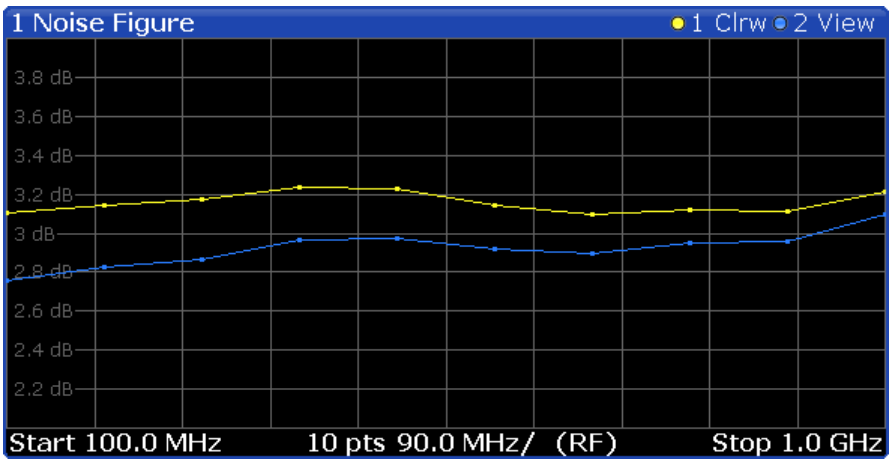
Table 4-1: Overview of available trace modes

Trace Mode	Description
Blank	Hides the selected trace.
Clear Write	Overwrite mode: the trace is overwritten by each sweep. This is the default setting.
View	The current contents of the trace memory are frozen and displayed.

Each time the trace mode is changed, the selected trace memory is cleared.

The default trace mode for the first trace is Clear/Write. For trace 2-4, the deafult trace mode is Blank. If you require another mode, you have to set it manually.

As you can have up to four traces simultaneously, you can compare the results with different measurement configurations, e.g. if you freeze a trace and use it as a memory trace.



If you change the scaling of the y-axis, the R&S FSWP automatically adapts the trace data to the changed display range. This allows an amplitude zoom to be made after the measurement in order to show details of the trace.

4.9 Using Markers

Markers are used to mark points on traces, to read out the results of a particular measurement point or compare results of different traces. The noise application provides four markers.

When you activate a marker, the application automatically positions it on the first measurement point (left border of the diagram) of trace 1, regardless of how many traces are active. A marker is always positioned on the same horizontal position in all active measurement windows. If you change the position of a marker in one window, the application adjusts the position of that marker in all other measurement windows. Thus, the marker results for a specific marker are always for the same frequency, which makes it easier to compare results.

Markers in single frequency mode

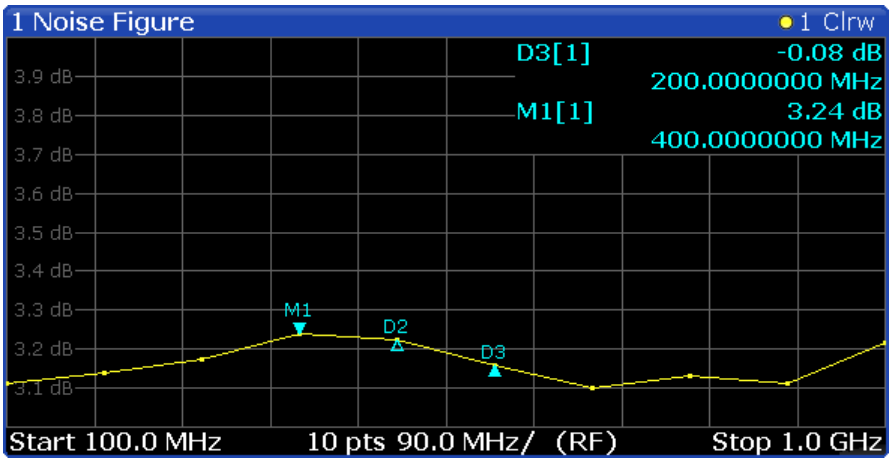
When you use a marker for single frequency measurements, the marker is positioned on a particular index value and not a particular measurement point. This means that during continuous measurements, the marker remains on the index value you have put it on and will not move down the line with the results.

To move a marker, you can use several methods.

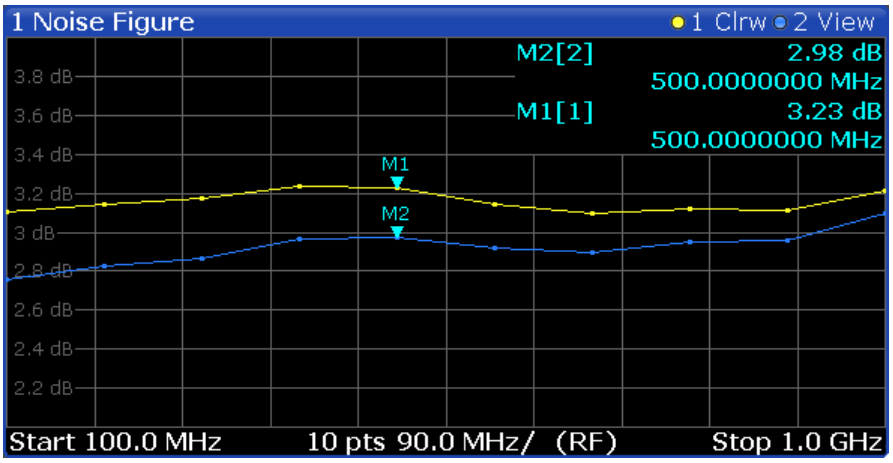
- Enter a particular measurement frequency in the input field that opens when you activate a marker.
- Move the marker around with the rotary knob or the cursor keys.
- Drag the marker around using the touchscreen.

All markers can be used either as normal markers or delta markers. A normal marker indicates the absolute signal value at the defined position in the diagram. A delta

marker indicates the value of the marker relative to the specified reference marker (by default marker 1).



The application always positions the marker on the trace with the lowest number that is in Clear/Write trace mode. To set the marker on another trace, use the Marker to Trace function. With this function, you can also position a marker on a trace that is in View trace mode, e.g. to compare measurement results. Note that at least one active marker has to be a normal marker.



The application shows the results at the marker position directly in the diagram area (up to two markers) or in the marker table (if you use more than two markers).

Marker information in diagram area

By default, the results of the last two markers or delta markers that were activated are displayed in the diagram area.

The following information is displayed there:

- The marker type (M for normal, D for delta, or special function name)
- The marker number (1 to 4)
- The assigned trace number in square brackets [ ]
- The marker value on the y-axis
- The marker position on the x-axis

Marker information in marker table

In addition to the marker information displayed within the diagram area, a separate marker table may be displayed in a separate window. For more information on the contents of the marker table see "Marker Table" on page 22.

5 Configuration

Noise figure measurements require a special application on the R&S FSWP, which you activate using the MODE key.

The Noise Source Control connector on the R&S FSWP is also a prerequisite for the Noise measurement application. Without this connector, no measurement can be performed.

When you activate a measurement channel in the Noise application, a measurement for the input signal is started automatically with the default configuration. The "Noise Figure" menu is displayed and provides access to the most important configuration functions.

Unavailable hardkeys

Note that the AMPT, AUTO SET, BW, TRIG and MKR FUNC keys have no contents and no function in the Noise Figure application.

- Configuration Overview....40
- Defining the Measurement Frequency....42
- Selecting DUT Characteristics....47
- Configuring the Noise Source....49
- Configuring Additional Loss....55
- Configuring the Analyzer....58
- Using the Uncertainty Calculator....62
- Performing Measurements....67
- Configuring Inputs and Outputs of the R&S FSWP....68

5.1 Configuration Overview

Throughout the measurement channel configuration, an overview of the most important currently defined settings is provided in the "Overview". The "Overview" is displayed when you select the "Overview" icon, which is available at the bottom of all softkey menus.

In addition to the main measurement settings, the "Overview" provides quick access to the main settings dialog boxes. The individual configuration steps are displayed in the order of the data flow. Thus, you can easily configure an entire measurement channel from input over processing to output and analysis by stepping through the dialog boxes as indicated in the "Overview".

In particular, the "Overview" provides quick access to the following configuration dialog boxes (listed in the recommended order of processing):

1. Noise Source
   See chapter 5.4, "Configuring the Noise Source", on page 49.
2. Spectrum Analyzer
   See chapter 5.6, "Configuring the Analyzer", on page 58.
3. Input and Output Losses
   See chapter 5.5, "Configuring Additional Loss", on page 55.

To configure settings

► Select any button in the "Overview" to open the corresponding dialog box.
Select a setting in the channel bar (at the top of the measurement channel tab) to change a specific setting.

Preset Channel

Select the "Preset Channel" button in the lower lefthand corner of the "Overview" to restore all measurement settings **in the current channel** to their default values.

Note that the PRESET key restores the entire instrument to its default values and thus closes **all measurement channels** on the R&S FSWP (except for the default channel)!

Remote command:
`SYSTem:PRESet:CHANnel[:EXECute]` on page 98

Specifics for
The measurement channel may contain several windows for different results. Thus, the settings indicated in the "Overview" and configured in the dialog boxes vary depending on the selected window.

Select an active window from the "Specifics for" selection list that is displayed in the "Overview" and in all window-specific configuration dialog boxes.

The "Overview" and dialog boxes are updated to indicate the settings for the selected window.

5.2 Defining the Measurement Frequency

The "DUT" button or the "Frequency Settings" softkey open a dialog to configure the measurement frequencies.

- Defining a Frequency Set....42
- Configuring Single Frequency Measurements....45
- Using a Frequency Table....46

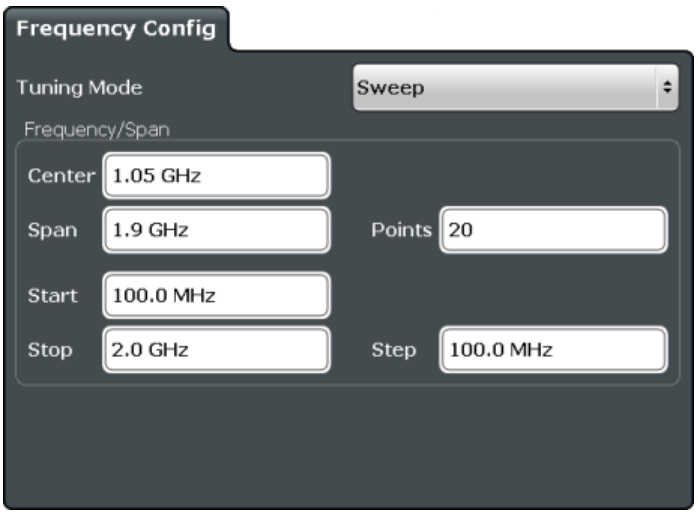
5.2.1 Defining a Frequency Set

The "Frequency Config" tab in the "Frequency Settings" dialog box contains settings that define the frequency characteristics for the measurement.

The information in this tab is also the basis for an automatic population of the frequency table. All parameters of this dialog are interdependent. If you change one parameter, at least one other parameter will be changed by the application.

In order to get accurate results, changing a frequency set may require a new calibration.

Preamplifier
If a preamplifier is used, make sure the defined (and possibly upconverted) IF frequencies for the measurement stay below the maximum frequency the preamplifier supports. For the R&S FSWP-B22 option, the maximum frequency is 7 GHz. However, the preamplifier can be activitated or deactivated individually for different tuning modes. For example, for a sweep mode which requires a span above 7 GHz it is deactivated, while for a single frequency measurement at 1 GHz it can be activated.



Tuning Mode 43
Center 43
Span 44
Start and Stop Frequency 44
(Measurement) Points 44
Step 44

Tuning Mode
Selects the tuning or measurement mode.

For more information see chapter 4.1, "Tuning Modes", on page 24.

Tuning mode selection is also available via softkeys ("Sweep Mode", "Frequency Table Mode", "Single Frequency Mode") in the "Sweep" menu.

Note: A preamplifier can be activitated or deactivated individually for different tuning modes. When you switch tuning modes, the defined preamplifier state is adapted.

"Sweep"	The measurement is based on an automatically generated frequency set.
"Frequency Table"	The measurement is based on a customized frequency table. For more information see chapter 5.2.3, "Using a Frequency Table", on page 46.
"Single Frequency"	The measurement measures a single frequency only. For more information see chapter 5.2.2, "Configuring Single Frequency Measurements", on page 45.

Remote command:
Frequency list measurement:
`[SENSe:]CONFigure:LIST:CONTinuous` on page 107
`[SENSe:]CONFigure:LIST:SINGLe` on page 108
Single frequency measurement:
`[SENSe:]CONFigure:FREQuency:CONTinuous` on page 107
`[SENSe:]CONFigure:FREQuency:SINGle` on page 107

Center
Defines the center of the measurement frequency range.

If you change the center frequency, the application will change the start and stop frequency according to the span you have set.

The "Center" setting is also available via the FREQ key.

Remote command:
Frequency list measurement:
`[SENSe:]FREQuency:CENter` on page 108
Single frequency measurement:
`[SENSe:]FREQuency:SINGle` on page 109

Span
Defines the measurement span.

If you change the span, the application will change the start frequency, the stop frequency and the stepsize according to the center frequency and the measurement points.

The "Span" setting is also available via the SPAN key.

Remote command:
`[SENSe:]FREQuency:SPAN` on page 109

Start and Stop Frequency
Defines the start and stop frequencies.

If you change the start or stop frequency, the application will change the center frequency, the span and the measurement points according to the stop or start frequency and the stepsize.

The "Start" and "Stop" settings are also available via the FREQ key.

Remote command:
Start frequency:
`[SENSe:]FREQuency:STARt` on page 110
Stopf frequency:
`[SENSe:]FREQuency:STOP` on page 110

(Measurement) Points
Defines the measurement points.

In case of frequency list measurements, the number of measurement points corresponds to the number of entries in the frequency table and therefore the number of measurements displayed in the graphical results.

If you change the measurement points, the application will change the stepsize according to the span.

The "Points" setting is also available via the SPAN key.

Remote command:
`[SENSe:]SWEep:POINts` on page 108

Step
Defines the frequency step size in the frequency table.

The stepsize corresponds to the distance between two consecutive measurement points.

If you change the stepsize, the application will change the measurement point according to the span.

The "Stepsize" setting is also available via the FREQ key.

Remote command:
[SENSe:]FREQuency:STEP on page 110

5.2.2 Configuring Single Frequency Measurements

The "Frequency Config" tab in the "Frequency Settings" dialog box contains settings that define the frequency characteristics for the measurement.

In order to get accurate results, changing the frequency may require a new calibration.

Single (Frequency)....45
Coupled to Sweep List....45
(Measurement) Points....46

Single (Frequency)
Defines the frequency that the single frequency measurement is performed on.

95fb1617687e42d0.htm

The "Single" setting is also available via the FREQ key.

Remote command:
[SENSe:]FREQuency:SINGle on page 109

Coupled to Sweep List
Couples or decouples frequency selection to the contents of a sweep list.

If you couple the frequency to the sweep list, the application allows you to select only the frequencies currently part of the frequency list. If you enter another frequency, the application automatically selects the nearest frequency of the frequency list. If the frequency list has been calibrated previously, calibration remains valid for those frequencies when you change the tuning mode.

If you turn the coupling off, you can define any frequency for single frequency measurements. Note however, that it may become necessary to calibrate the measurement for that frequency.

Remote command:
`[SENSe:]FREQuency:SINGle:COUPling` on page 109

(Measurement) Points
Defines the number of measurement points for single frequency measurements.

In case of single frequency measurements, the number of measurement points corresponds to the number of measurements (index values) performed on a single frequency.

For more information see "Single frequency measurements" on page 15.

The "Points" setting is also available via the SPAN key.

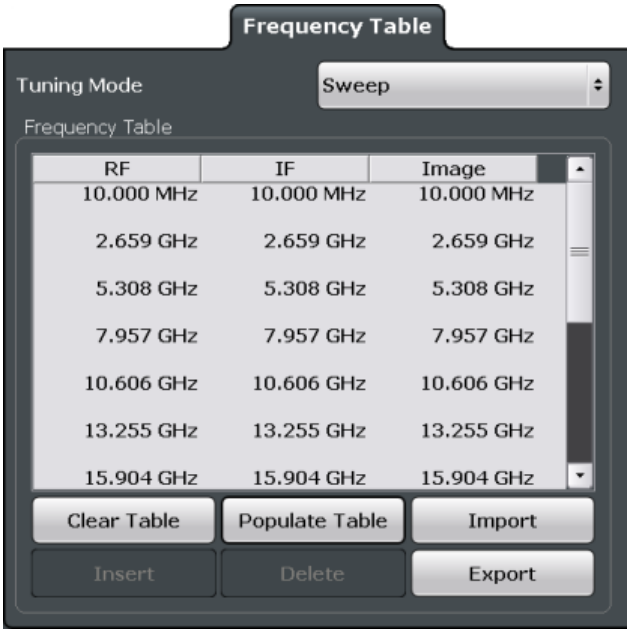
Remote command:
`[SENSe:]SWEep:POINts` on page 108

5.2.3 Using a Frequency Table

The "Frequency Table" tab in the "Frequency Settings" dialog box contains functionality to manage the measurement frequencies.

The application populates the table according to the information you have entered in the "Frequency Config" tab if you press the "Populate Table" button.

Note that changes to the frequency table take effect only if you have selected the "Frequency Table" tuning mode.



Frequency Table 47
Clear Table 47
Populate Table 47

Insert....47
Delete....47
Import / Export....47

Frequency Table
Shows the current measurement points.

The table is made up of one column that represents the measurement frequency. Each frequency corresponds to one measurement point. The length of the table is variable.

When you perform measurements in "Sweep" or "Single Frequency" tuning mode, the contents of the table have no effect on the measurement.

When you select a table entry in "Frequency Table" tuning mode, you can edit it or add a new frequency below the selected frequency. A new frequency has to be greater than the last table entry and smaller than the next table entry.

Clear Table
Deletes the contents of the table.

Populate Table
Populates or restores the measurement frequencies based on the center frequency, the start and stop frequencies, the span, the stepsize and the number of measurement points.

Remote command:
`[SENSe:]FREQuency:LIST:DATA` on page 108

Insert
Inserts a new measurement point above the one you have selected.

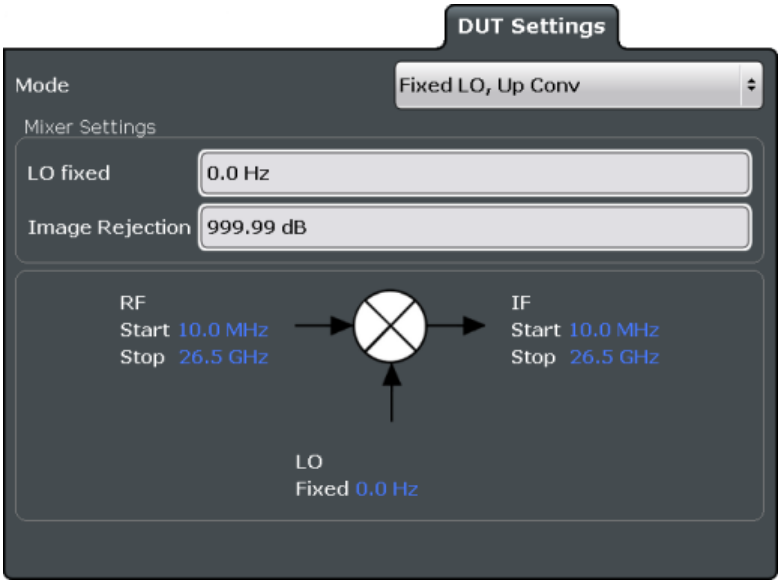
Delete
Deletes the currently selected measurement point.

Import / Export
Opens a dialog box to select an ENR table to import or export.

An import copies the ENR table into the default ENR table directory. An export copies the table to a location outside the default ENR table directory, e.g. a memory stick. The file extension has to be *.freq.

5.3 Selecting DUT Characteristics

The "DUT" button opens a dialog box to configure the characteristics of the DUT you are testing. The dialog box contains a schematic overview of the DUT input and output characteristics and the way it is integrated into the test setup.



Mode....48
LO Fixed....48
IF Fixed....48
Image Rejection....49

Mode
Selects the measurement mode.

The measurement mode you should use depends on the type of DUT you are testing. For more information see chapter 4.3, "DUT Types", on page 28.

Note: For upconverting measurements, if a preamplifier is used, make sure the upconverted frequencies for the measurement stay below the maximum frequency the preamplifier supports.

Remote command:
`[SENSe:]CONFigure:MODE:DUT` on page 111

LO Fixed
Defines a fixed LO frequency for measurements on frequency-converting DUTs with a fixed LO.

After you have defined the LO frequency, the application updates the frequency list accordingly.

The "LO" setting is also available via the FREQ key.

Remote command:
`[SENSe:]CONFigure:MODE:SYSTem:LO:FREQuency` on page 111

IF Fixed
Defines a fixed intermediary frequency (IF) for measurements on frequency-converting DUTs with a fixed IF.

After you have defined the intermediary frequency, the application updates the frequency list accordingly.

The "IF" setting is also available via the FREQ key.

Remote command:
`[SENSe:]CONFigure:MODE:SYSTem:IF:FREQuency` on page 111

Image Rejection
Turns image rejection of the DUT on and off.

If you set an image rejection of 0 dB, the image frequency passes completely. If you set a high image rejection (up to 999.99 dB), the image frequency is suppressed completely. For DUTs that have a partial image rejection, define the amount of suppression.

For more information see chapter 4.5, "Image Frequency Rejection", on page 31.

Remote command:
`[SENSe:]CORRection:IREJection` on page 112

5.4 Configuring the Noise Source

The "Noise Source" button or the "ENR Settings" softkey open a dialog to configure the characteristics of the noise source.

It is necessary to specify characteristics of the noise source you are using as close as possible in order to get accurate measurement results. The noise source characteristics are used to calculate the effective noise temperature of the noise source. The noise source characteristics should be supplied by its manufacturer.

- Selecting the Type of Noise Source....49
- Defining the Noise Source Characteristics....50
- Using an ENR or Temperature Table....52

5.4.1 Selecting the Type of Noise Source

The application allows you to use different kinds of noise sources, depending on the type of measurement you would like to perform.

- Diode
  Selects a noise source with diode characteristics. The frequency characteristics of the noise source are defined by the Excess Noise ratio (ENR).
- Resistor
  Selects a test setup that uses two resistors which act as a noise source. One of the resistors has a low noise or ambient temperature (a cold resistor), the other has a high noise or ambient temperature (a hot resistor). The noise characteristics of the resistor are defined by its noise temperatures T_{hot} and T_{cold}.
  T_{hot} is temperature of the resistor when it is turned on. T_{cold} is the temperature of the resistor when it is turned off.

You can select the type of noise source and its characteristics independently for the Calibration and the Measurement. When you select the resistor noise source, the

application automatically starts the manual measurement mode and communicates that fact with a message at the bottom of the dialog box.

Remote command:

Measurement: `[SENSe:]CORRection:ENR[:MEASurement]:TYPE` on page 118

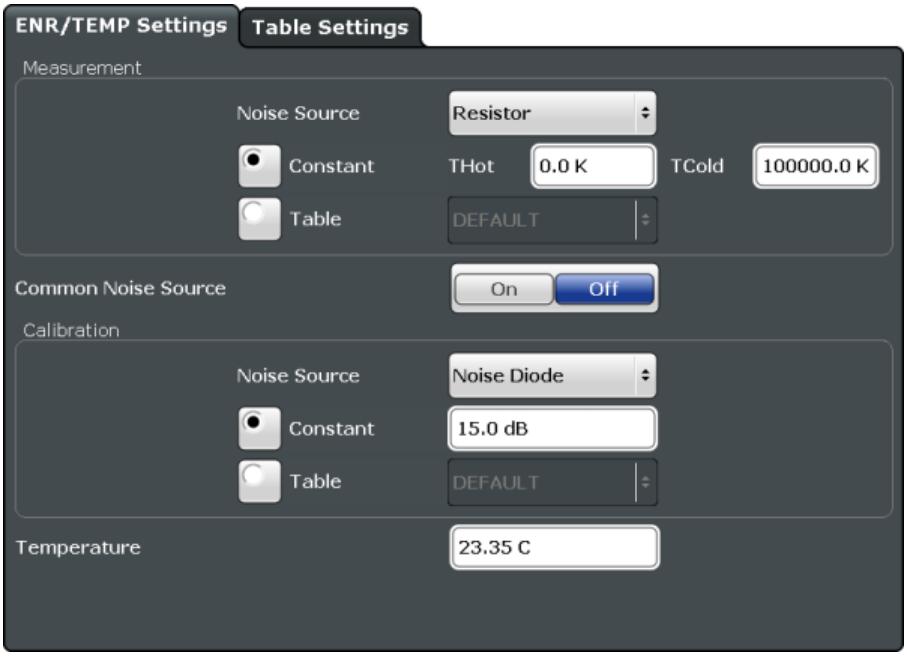
Calibration: `[SENSe:]CORRection:ENR:CALibration:TYPE` on page 114

5.4.2 Defining the Noise Source Characteristics

The "ENR/TEMP Settings" tab in the "ENR Settings" dialog box contains settings to characterize the noise source.

The noise characteristics of noise sources with diode characteristics are ususally defined by their ENR (Excess Noise Ratio). The noise characteristics of noise sources with resistor characteristics are defined by their noise (or ambient) temperatures (T_{hot} and T_{cold}). T_{cold} is typically at a very low temperature of liquid nytrogen or liquid helium.

Both noise source types may have different ENR values during the calibration and the measurement stage. You can use either the same type of noise source for both calibration and measurement, or use different types of noise sources for calibration and measurement.



Measurement....51
Common Noise Source....51
Calibration....51
Temperature....52

Measurement
Selects the source of the ENR or temperature values.

The frequency characteristics may be approximated by a constant or be based on a ENR or temperature table.

If the ENR or temperature is a constant, the same values are used for all frequencies in the frequency table. If you have selected a constant ENR, you have to define its magnitude in the input field next to the radio button. If you have selected a constant temperature, you have to define the temperatures of the resistor in the input fields next to the radio button. T_{hot} is the temperature of a resistor with a low noise or ambient temperature; T_{cold} is the temperature of a resistor with a high noise or ambient temperature.

If the noise characteristics are based on a table, the ENR level and temperatures typically depend on the measurement frequency. You can select an existing table from the dropdown menu next to the radio button, if it is active. For more information on ENR and temperature tables see chapter 5.4.3, "Using an ENR or Temperature Table", on page 52.

When "Common Noise Source" is on, the ENR is used for both measurement and calibration.

Remote command:
ENR mode: `[SENSe:]CORRection:ENR[:MEASurement]:MODE` on page 118
Constant ENR: `[SENSe:]CORRection:ENR[:MEASurement]:SPOT` on page 118
Select table: `[SENSe:]CORRection:ENR[:MEASurement]:TABLe:SELect` on page 116
Constant temperature: `[SENSe:]CORRection:ENR[:MEASurement]:SPOT:COLD` on page 119
Constant temperature: `[SENSe:]CORRection:ENR[:MEASurement]:SPOT:HOT` on page 119

Common Noise Source
Turns the use of a common ENR on and off.

Common ENRs have the same characteristics for the measurement and calibration. If you turn common ENR off, you can define an additional ENR to be used during calibration.

This is recommended in case of measurements on frequency converting DUTs, if one noise source does not cover the frequency range at the DUT input (RF) and the frequency range for calibration (IF).

Remote command:
`[SENSe:]CORRection:ENR:COMMon` on page 115

Calibration
Selects the source of the ENR or temperature values used during calibration.

The frequency characteristics may be a constant or be based on a ENR or temperature table.

If the ENR or temperature is a constant, the same value is used for all frequencies in the frequency table. If you have selected a constant ENR, you can also define its value in the input field next to the radio button. If you have selected a constant temperature, you have to define the temperatures of the resistor in the input fields next to the radio button. T_{hot} is the temperature of a resistor with a low noise or ambient temperature; T_{cold} is the temperature of a resistor with a high noise or ambient temperature.

If the noise source characteristics are based on a table, the ENR level and temperature depend on the measurement frequency. In that case, the values are interpolated to the measurement points. You can select a table from the dropdown menu next to the radio button, if it is active. For more information on ENR tables see chapter 5.4.3, "Using an ENR or Temperature Table", on page 52.

The calibration settings are available if the "Common Noise Source" is off.

Remote command:
ENR mode: `[SENSe:]CORRection:ENR:CALibration:MODE` on page 113
Constant ENR: `[SENSe:]CORRection:ENR:CALibration:SPOT` on page 113
Select table: `[SENSe:]CORRection:ENR:CALibration:TABLe:SELect` on page 114
Constant temperature: `[SENSe:]CORRection:ENR:CALibration:SPOT:COLD` on page 112
Constant temperature: `[SENSe:]CORRection:ENR:CALibration:SPOT:HOT` on page 113

Temperature
Defines the absolute room temperature in degree Celsius or Fahrenheit.

The room temperature is required for the calculation of the real ENR of the noise source, because an ENR table is based on a temperature of 290K.

To change the unit of the temperature from Celsius to Fahrenheit, change the date format from "DE" to "US" in the "General" display settings.

- Press the SETUP key.
- Press the "Display" softkey.
- Select the "General" tab.
- Select "DE" for Celsius or "US" for Fahrenheit.

Note: If you define the temperature via remote control, the unit is degree Kelvin.

Remote command:
`[SENSe:]CORRection:TEMPerature` on page 119

5.4.3 Using an ENR or Temperature Table

The "Table Settings" tab in the "ENR/TEMP Settings" dialog box contains the functionality to create and edit ENR or temperature tables.

ENR or temperature tables contain the noise source characteristics for particular frequencies. If the table does not contain ENR or temperature values for one of the measurement frequencies, the application will interpolate between the values.

The "Table Settings" tab contains a list of ENR and temperature tables currently available on the R&S FSWP and shows the table currently in use if the "ENR/TEMP Settings" are enabled.

In addition, the tab contains functionality to create new tables and modify existing ones.

Noise Source....53
New....53
Edit....53
Copy To....54
Delete....54
Import / Export Table....54
Edit Table....54

Noise Source
Selects the type of noise source you are using for the measurement.

The noise source type affects the data type that the table contains. In case of a "Noise Diode", the table contains the ENR values of the noise source you are using. In case of a "Resistor", the table contains the noise temperatures of the resistors (T_{hot} and T_{cold}).

For more information on the noise source types see chapter 5.4.1, "Selecting the Type of Noise Source", on page 49.

Remote command:
`[SENSe:]CORRection:ENR[:MEASurement]:TYPE` on page 118

New
Opens the Edit Table dialog box to create a new table.

The contents of the dialog box are empty.

Remote command:
Table selection: `[SENSe:]CORRection:ENR:CALibration:TABLe:SELect` on page 114
and: `[SENSe:]CORRection:ENR[:MEASurement]:TABLe:SELect` on page 116
Diode: `[SENSe:]CORRection:ENR[:MEASurement]:TABLe:DATA` on page 115
Resistor: `[SENSe:]CORRection:ENR[:MEASurement]:TABLe:TEMPerature[:DATA]` on page 116

Edit
Opens the Edit Table dialog box to modify the selected table.

Remote command:
Table selection: `[SENSe:]CORRection:ENR:CALibration:TABLe:SELect` on page 114
and: `[SENSe:]CORRection:ENR[:MEASurement]:TABLe:SELect` on page 116
Diode: `[SENSe:]CORRection:ENR[:MEASurement]:TABLe:DATA` on page 115
Resistor: `[SENSe:]CORRection:ENR[:MEASurement]:TABLe:TEMPerature[:DATA]` on page 116

Copy To
Opens the Edit Table dialog box to modify the selected table and save it under a new name.

Delete
Deletes the selected table.

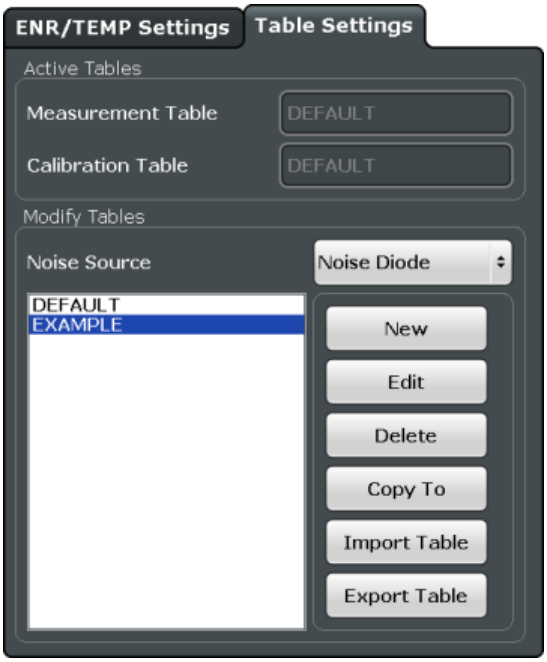
Remote command:
Diode: `[SENSe:]CORRection:ENR[:MEASurement]:TABLe:DELete` on page 115
Resistor: `[SENSe:]CORRection:ENR[:MEASurement]:TABLe:TEMPerature:DELete` on page 117

Import / Export Table
Opens a dialog box to select a table to import or export.

An import copies the ENR or temperature table into the default table directory. An export copies the table to a location outside the default table directory, for example a memory stick. The file extension has to be *.enr.

Edit Table
Defines the noise source characteristics of a irregular noise source or the loss characteristics of additional measurement equipment.

The noise source and loss tables are made up of up to 500 data points. A data point consists of a frequency and its corresponding ENR, temperature or loss value. The ENR and temperature values should be supplied by the manufacturer of the noise source or resistor. The loss characterictics of measurement equipment should also be supplied by the manufacturer.



"Name" Name of the ENR, temperature or loss table.

"Comment" Comment for the ENR, temperature or loss table.

"Frequency"	Frequency of a particular ENR, temperature or loss value.
"Value"	ENR value or loss in dB. In case of a resistor, the characteristics of the resistor are defined by the noise temperatures T_{hot} and T_{cold} instead of a single value. The unit in that case is Kelvin (degrees).
"Clear Table"	Deletes the contents of the table (frequencies and values) or the loss table.
"Insert"	Inserts a new data point above the selected one.
"Delete"	Deletes the selected data point.
"Save"	Saves the able.
"Cancel"	Exits the "Edit Table" dialog box and returns to the result diagram.

Remote command:
Edit ENR table: `[SENSe:]CORRection:ENR[:MEASurement]:TABLe:DATA` on page 115
Edit temperature table: `[SENSe:]CORRection:ENR[:MEASurement]:TABLe:TEMPerature[:DATA]` on page 116
Edit input loss table: `[SENSe:]CORRection:LOSS:INPut:TABLe` on page 121
Edit output loss table: `[SENSe:]CORRection:LOSS:OUTPut:TABLe` on page 122

5.5 Configuring Additional Loss

The "Loss Input"/"Loss Output" buttons or the "Loss Settings" softkey open a dialog to configure the loss characteristics of additional equipment in the test setup like cables or attenuators at the DUT input or output. The characteristics of these should be supplied by the manufacturer.

Note that loss is only taken into account during the measurement and not during calibration because the noise source is connected directly to the analyzer input.

Treatment of losses in case of resistor noise sources

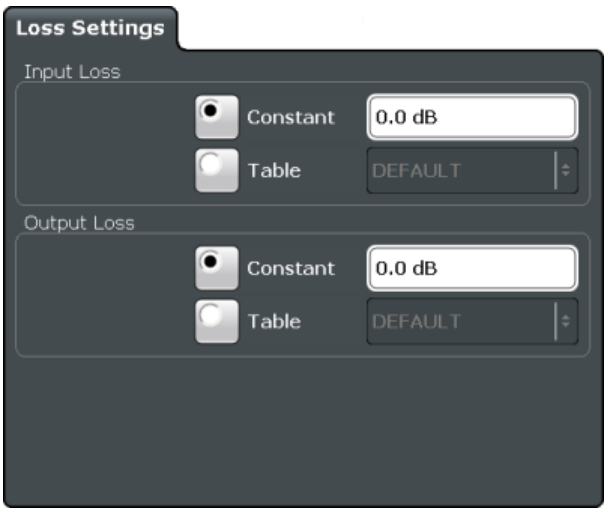
When you are using a resistor as a noise source, it is not possible to change the loss characteristics.

When you change back to using a diode as a noise source, the previous loss settings are **not** restored. In that case, the best way to handle loss settings is to store them in a loss table to still have them available later on.

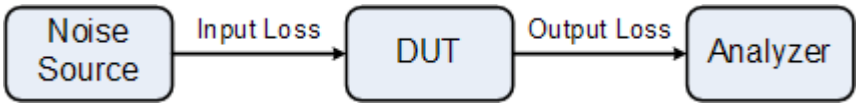
- Defining Loss 55
- Using a Loss Table 57

5.5.1 Defining Loss

The "Loss Settings" tab in the "Loss Settings" dialog box contains settings to define the loss characteristics of miscellaneous equipment in the test setup.



You can define the loss characteristics of the signal path to the DUT input and the signal path from the DUT output to the analyzer.



Input Loss....56
Output Loss....56

Input Loss
Selects the source of losses between the noise source and the DUT input.

The input loss is the sum of all losses caused by the measurement equipment. The loss may be constant or be based on a loss table.

If the loss is constant, the same loss is used for all frequencies in the frequency table. If you have selected a constant loss, you can also define its value in the input field next to the radio button.

If the loss is based on a table, the loss values are interpolated to the measurement frequencies. You can select a table from the dropdown menu next to the radio button, if it is active. For more information on loss tables see chapter 5.5.2, "Using a Loss Table", on page 57.

Remote command:
Loss mode:
`[SENSe:]CORRection:LOSS:INPut:MODE` on page 120
Constant loss:
`[SENSe:]CORRection:LOSS:INPut:SPOT` on page 120
Select loss table:
`[SENSe:]CORRection:LOSS:INPut:TABLe:SELect` on page 121

Output Loss
Selects the source of loss between the DUT output and the RF input of the analyzer.

The output loss is the sum of all losses caused by the measurement equipment (e.g. connectors, cables or attenuators). The loss may be constant or be based on a loss table.

If the loss is constant, the same loss is used for all frequencies in the frequency table. If you have selected a constant loss, you can also define its value in the input field next to the radio button.

If the loss is based on a table, the loss values are interpolated to the measurement frequencies. You can select a table from the dropdown menu next to the radio button, if it is active. For more information on loss tables see chapter 5.5.2, "Using a Loss Table", on page 57.

Remote command:
Loss mode:
`[SENSe:]CORRection:LOSS:OUTPut:MODE` on page 121
Constant loss:
`[SENSe:]CORRection:LOSS:OUTPut:SPOT` on page 122
Select loss table:
`[SENSe:]CORRection:LOSS:OUTPut:TABLe:SELect` on page 123

5.5.2 Using a Loss Table

The "Table Settings" tab in the "Loss Settings" dialog box contains the functionality to create and edit loss tables.

Loss table contain the loss characteristics of additional frequency dependent equipment in the test setup. If you are using a loss table, the loss values may be different on each frequency that is measured. If the table does not contain a loss for one of the measurement frequencies, the application will interpolate between values.

The "Table Settings" tab contains a list of loss tables currently available on the R&S FSWP and shows the tables you are currently using if you have selected one in the "Loss Settings" tab.

In addition, the tab contains functionality to create new tables and modify existing ones.

New....57
Edit....58
Copy To....58
Delete....58
Import / Export Table....58

New
Opens the Edit Table dialog box to create a new loss table.

The contents of the dialog box are empty.

Remote command:
Create input loss table:
`[SENSe:]CORRection:LOSS:INPut:TABLe` on page 121
Create output loss table:
`[SENSe:]CORRection:LOSS:OUTPut:TABLe` on page 122

Edit
Opens the Edit Table dialog box to modify the selected table.

Remote command:
Edit input loss table:
`[SENSe:]CORRection:LOSS:INPut:TABLe` on page 121
Edit output loss table:
`[SENSe:]CORRection:LOSS:OUTPut:TABLe` on page 122

Copy To
Opens the Edit Table dialog box to modify the selected table and save it under a new name.

Delete
Deletes the selected table.

Remote command:
Delete input loss table:
`[SENSe:]CORRection:LOSS:INPut:TABLe:DELete` on page 121
Delete output loss table:
`[SENSe:]CORRection:LOSS:OUTPut:TABLe:DELete` on page 123

Import / Export Table
Opens a dialog box to select a loss table to import or export.

An import copies the loss table into the default loss table directory. An export copies the table to a location outside the default loss table directory, e.g. a memory stick. The file extension has to be *.loss.

5.6 Configuring the Analyzer

The "Spectrum Analyzer" button or the "Meas Settings" softkey open the "Measurement Settings" dialog box to set up general measurement characteristics.

- Configuring the Measurement....58
- Configuring Level Characteristics....60

5.6.1 Configuring the Measurement

The measurement settings include parameters directly related to the measurement itself.

2nd Stage Correction....59
Resolution Bandwidth (RBW)....59
Sweep Time....59
Settling Time....59
Average....59

2nd Stage Correction
Turns 2nd stage correction on and off.

If 2nd stage correction is on, the application excludes the inherent noise of the analyzer from the measurement results.

If 2nd stage correction is off, the application does not correct the measurement results, even if a valid calibration has been performed. Note that correction data does not get lost if you turn off the 2nd stage correction.

For more information see chapter 4.6, "Calibration (2nd Stage Correction)", on page 33.

Remote command:
`[SENSe:]CONFigure:CORRection` on page 123

Resolution Bandwidth (RBW)
Defines the resolution bandwidth for the measurement.

For more information on the resolution bandwidth see chapter 4.7, "Separating Signals by Selecting an Appropriate Resolution Bandwidth", on page 36.

Remote command:
`[SENSe:]BANDwidth[:RESolution]` on page 125

Sweep Time
Defines the sweep time for the measurement.

The sweep time is the time it takes the analyzer to perform a measurement at one measurement frequency.

Note that noise measurements perform two measurements during one sweep. One with the noise source turned on, one with the noise source turned off.

Remote command:
`[SENSe:]SWEep:TIME` on page 126

Settling Time
Defines the settling time of the DUT and the noise source.

Most noise sources need a certain amount of time to settle after you turn them on. Low-frequency DUTs may require a certain time until its coupling capacitators have been charged or discharged. Both are defined as the settling time. For details on the settling time refer to the datasheet of the noise source.

Remote command:
`SYSTem:CONFigure:DUT:STIMe` on page 127

Average
Defines the number of measurements that are used to average the results.

The more measurements you include in the averaging, the more accurate and stable the results will be. However, accuracy and stability comes at the price of measurement speed.

Remote command:
`[SENSe:]SWEep:COUNt` on page 126

5.6.2 Configuring Level Characteristics

The level and range settings configure all parameters related to the vertical diagram axis.

Ref Level....60
Auto Level Range....61
RF Attenuation....61
Preamplifier....61

Ref Level
Turns automatic determination of the reference level on and off.

The reference level is the power level the R&S FSWP expects at the RF input. Keep in mind that the noise signal has a high crest factor. Thus, the reference level has to be set at the peak envelope power of the noise signal, not the mean power in order to avoid an instrument overload.

The reference level should be about 5 to 15 dB above the noise display that occurs with the DUT connected and the noise source activated.

To get the best dynamic range, you have to set the reference level as low as possible. At the same time, make sure that the maximum signal level does not exceed the reference level. If it does, it may overload the RF and IF stages of the analyzer, regardless of the signal power. Measurement results may deteriorate.

Note that the signal level at the A/D converter may be stronger than the level the R&S FSWP displays, depending on the current resolution bandwidth. This is because the resolution bandwidths are implemented digitally after the A/D converter.

If automatic detection of the reference level is on, the application performs a measurement to determine the ideal reference level. The time of this measurement depends on the state of the "2nd Stage Correction".

- 2nd Stage Correction is on
  The application determines the reference level before the calibration starts. The reference level is based on several test measurements on the start frequency.
  For more information see "Auto Level Range" on page 61.
- 2nd Stage Correction is off

The application determines the reference level before the measurement begins. The reference level is based on the measurement of the first frequency that is measured. After this measurement is done, the application resumes the measurement.

If manual selection of the reference level is on, you can define the reference level in the corresponding input field.

Note: Reference level. Even for DUTs with a high-ripple frequency response it might be useful to enter the reference level manually, because determining the reference level automatically might not always result in optimal settings.

Remote command:
Manual reference level:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel` on page 124
Automatic reference level:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:AUTO` on page 124

Auto Level Range
Defines the maximum expected gain of the DUT.

The application uses the auto level range to determine the reference level automatically if the 2nd stage correction is on.

Note that the range should not exceed the actual gain of the DUT by more than 10 dB.

Remote command:
`SYSTem:CONFigure:DUT:GAIN` on page 126

RF Attenuation
Defines the RF attenuation of the analyzer.

The attenuation is applied to the signal at the RF input.

Attenuation affects the quality of the noise measurement results. For a low noise figure of the analyzer (and thus more accurate measurement results), you should keep the attenuation as low as possible. No attenuation is best. However, some high power DUTs require attenuation to avoid an overload of the analyzer. An attenuation of 10 dB will give better input VSWR of the analyzer, but will result in a deteriorating noise figure.

Remote command:
`INPut:ATTenuation` on page 124

Preamplifier
Turns the preamplifier on and off.

The preamplifier should be turned on for a low inherent noise of the analyzer.

For R&S FSWP26 or higher models, the gain is 30 dB if the preamplifier is activated.

For the other models, you can select a gain of 15 dB or 30 dB.

Remote command:
`INPut:GAIN:STATe` on page 125

5.7 Using the Uncertainty Calculator

Noise figure measurements are subject to uncertainty. This measurement uncertainty has to be considered when making a noise figure measurement. The noise figure measurement will be meaningless if the measurement uncertainty is too large. Knowing the uncertainty of the noise figure measurement adds value especially when comparing measurement results.

Note that the noise figure uncertainty ist not calculated for frequencies above 67 GHz because input VSWR values are not specified.

Uncertainty values and systematic error recognition

Note that the uncertainty calculation only takes systematic measurement inaccuracies into account.

The most significant inaccuracies are:

- uncertainties of the noise source and the analyzer
- input and output matching
- noise figure and gain of the DUT
- noise figure of the analyzer

The accuracy of the measurement may be additionally affected by insufficient repeatability during calibration or measurement.

The repeatability is mainly affected by:

- signal-to-noise ratio during calibration and measurement
- measurement time (if it is too short)
- environmental conditions (e.g. a change in the temperature between measurements)
- mechanical stability of the test setup

For more background information on noise figure measurement uncertainty refer to the application note "The Y-Factor Technique for Noise Figure Measurement" available for download on the Rohde & Schwarz homepage (http://www.rohde-schwarz.com/en/applications/the-y-factor-technique-for-noise-figure-measurements-application-note_56280-15484.html).

In addition to the parameters described here, the application also considers several parameters from the general measurement configuration when calculating the uncertainty.

- Measurement mode
- 2nd Stage Correction
  If 2nd stage correction is on, but no calibration data is available, uncertainty is calculated without the 2nd stage correction data.
- Internal preamplification
- RF Attenuation
- Temperature

- ENR values

5.7.1 Configuring Noise Source Characteristics

The Uncertainty Calculator supports individual characteristics for a noise source used during calibration and the measurement.

If you are using a Common ENR, the application assumes that the Output Match and ENR Uncert(ainty) are the same during calibration and measurement. Only the "Measurement Noise Source" parameters are displayed.

If you are using a different noise source during calibration and measurement, the Uncertainty Calculator adds an additional Output Match and ENR Uncert(ainty) required for uncertainty calculation during calibration.

Note that you have to turn off the Common Noise Source if you have to define the values of the noise source used during calibration.

Common Source for Meas and Cal....63
Output Match....63
ENR Uncert(ainty)....63
Temperature Uncert(ainty)....64

Common Source for Meas and Cal
Controls the way the application calculates the uncertainty for the noise source.

Turn on the switch when you use the same noise source during calibration and measurement. Only one set of fields to define the noise source characteristics is available. The application calculates the uncertainty according to the values you have entered in there.

Turn the switch off when you use different noise sources during calibration and measurement. The application shows an additional set of fields to define the noise source characteristics. The uncertainty calculation also includes these values.

The switch is available if you have turned on Common Noise Source.

Remote command:
`CALCulate:UNCertainty:COMMon` on page 128

Output Match
Defines the output match of the noise source you are using.

You can define the output match either as the VSWR or as the return loss (RL).

Refer to the datasheet of the noise source for these values.

Remote command:
`CALCulate:UNCertainty:MATCh:SOURce[:VSWR]` on page 133
`CALCulate:UNCertainty:MATCh:SOURce:RL` on page 133
`CALCulate:UNCertainty:MATCh:SOURce:CALibration[:VSWR]` on page 133
`CALCulate:UNCertainty:MATCh:SOURce:CALibration:RL` on page 133

ENR Uncert(ainty)
Defines the uncertainty of the excess noise ratio of the noise source you are using.

Refer to the datasheet of the noise source for this value.

Available for noise sources with diode characteristics.

Remote command:
CALCulate:UNCertainty:ENR:UNCertainty on page 130
CALCulate:UNCertainty:ENR:CALibration:UNCertainty on page 129

Temperature Uncert(ainty)
Defines the uncertainty of the hot and cols temperatures of the noise source you are using.

Refer to the datasheet of the noise source for these values.

Available for resistor noise sources.

Remote command:
CALCulate:UNCertainty:ENR:UNCertainty:COLD on page 131
CALCulate:UNCertainty:ENR:UNCertainty:HOT on page 131
CALCulate:UNCertainty:ENR:CALibration:UNCertainty:COLD on page 130
CALCulate:UNCertainty:ENR:CALibration:UNCertainty:HOT on page 130

5.7.2 Configuring DUT Characteristics

Input / Output Match....64
Use Measurement Values....64

Input / Output Match
Defines the match at the DUT input and output.

You can define the match either as the VSWR or as the return loss (RL). If you define the VSWR or the return loss, the application automatically calculates the other.

If these values are not defined in the DUT datasheet, determine these values, for example, with a network analyzer.

Remote command:
CALCulate:UNCertainty:MATCh:DUT:IN:[VSWR] on page 131
CALCulate:UNCertainty:MATCh:DUT:IN:RL on page 131
CALCulate:UNCertainty:MATCh:DUT:OUT:[VSWR] on page 132
CALCulate:UNCertainty:MATCh:DUT:OUT:RL on page 132

Use Measurement Values
Turns automatic determination of the DUT characteristics used for the uncertainty calculation on and off.

If on, the application calculates the uncertainty with the DUT characteristics (noise figure, gain and frequency) resulting from the noise figure measurement. In case of this method, the application calculates the uncertainty for each measurement point (or frequency) based on the noise figure and gain results of the last measurement.

If you have selected automatic determination of the DUT characterictics, the application does not show a result in the "NF Uncertainty +/-" field in the dialog box. Instead, to view the uncertainty at all measurement points, use the "Result Table".

If off, define the gain, noise figure and frequency of the DUT manually for a single frequency. With this manual determination of the DUT characteristics, the application only calculates the uncertainty for that frequency and shows the result in the "NF Uncertainty +/-" field in the dialog box.

- Noise Figure of the DUT
- Gain of the DUT
- Frequency of the DUT

Remote command:
Control automatic DUT characteristics determination:
`CALCulate:UNCertainty:DATA:RESults` on page 129
Manual definition of DUT characteristics:
`CALCulate:UNCertainty:DATA:NOISe` on page 129
`CALCulate:UNCertainty:DATA:GAIN` on page 128
`CALCulate:UNCertainty:DATA:FREQuency` on page 128

5.7.3 Configuring Analyzer Characteristics

For the analyzer characteristics, the application always uses the data specified in the datasheet of the R&S FSWP model you are using. Thus, it is not possible to change or adjust the analyzer characteristics in any way. The uncertainty calculation takes several analyzer characteristics into account. Of those, it shows the following as read only fields in the user interface.

- Input match (VSWR and return loss)
- Gain uncertainty
- Noise figure uncertainty
- Noise figure of the analyzer

However, if you are using an external preamplifier in the test setup, you have to specify its characteristics in order to get a valid uncertainty result. If you specify an external preamplifier, the application automatically calculates and updates the analyzer characteristics based on the characteristics of the preamplifier.

SCPI command:

`CALCulate:UNCertainty:PREamp:STATe` on page 134

Refer to the datasheet of the preamplifier you are using for the values you have to enter.

If you are using a preamplifier, you have to define the following characteristics.

Preamplifier noise figure (PA NF)

Defines the noise figure of the preamplifier.

SCPI command:

`CALCulate:UNCertainty:PREamp:NOISe` on page 134

Preamplifier Gain (PA Gain)

Defines the gain of the preamplifier.

SCPI command:

`CALCulate:UNCertainty:PREamp:GAIN` on page 134

Net spectrum analyzer noise figure

Shows the noise figure of the analyzer.

If you are using an external preamplifier, the application calculates the noise figure of the analyzer including the noise figure of the preamplfier and shows the result here.

If you do not use an external preamplifier, this value is the same as the noise figure of the analyzer shown in the "SA NF" field.

SCPI commands:

`CALCulate:UNCertainty:SANalyzer:GAIN:UNCertainty?` on page 135

`CALCulate:UNCertainty:SANalyzer:NOISe:UNCertainty?` on page 135

5.7.4 Guidelines and Results

The lower part of the dialog box contains measurement guidelines that provide information on the quality of measurement and the actual noise figure uncertainty.

Guidelines

The guidelines are an indicator of the quality of the measurement and an indicator the repeatability of the measurement.

The three guidelines are:

- Make sure that the noise figure of the DUT and the gain of the DUT is greater than the noise figure of the analyzer plus 1 dB.
- Make sure that the ENR of the noise source is greater than the noise figure of the DUT plus 5 dB.
- Make sure that the ENR of the noise source is greater than the noise figure of the analyzer plus 3 dB.

A short form of these guidelines is indicated in the "Uncertainty Calculation" dialog box. The dialog box also indicates if the guidelines have been met or not by a colored dot.

- Green light : guideline condition met.
- Yellow light : guideline condition not met, but within 1 dB of being met.
- Red light : guideline condition not met.

Note that the guidelines have no effect on the actual uncertainty that has been calculated and that they are only considered for measurements with 2nd Stage Correction.

Uncertainty

The "Uncertainty" result is shown only if you define the noise figure and gain characteristics of the DUT manually on a single frequency. In that case, the uncertainty shown in the "Uncertainty Calculation" dialog box is valid only for the DUT frequency you have defined.

The "Measurement Offset" evaluates the internal noise of the R&S FSWP that is added to the noise figure results. The measurement offset result is displayed when 2nd stage correction is turned off. When you turn on 2nd stage correction, the internal noise is automatically removed from the uncertainty results, so the measurement offset is not shown.

If you are using the noise figure and gain that has been determined during a measurement, the uncertainty is displayed only in the result table.

For more information see "Use Measurement Values" on page 64.

SCPI command:

`CALCulate:UNCertainty[:RESult]?` on page 134

5.8 Performing Measurements

This chapter contains all functionality necessary to control and perform noise figure measurements.

The contents of this chapter correspond to the contents of the "Sweep" menu. You can access the "Sweep" menu with the SWEEP key.

Continuous Sweep/RUN CONT....67
Single Sweep/ RUN SINGLE....68
Calibrate....68
Sweep Time....68
Meas Mode (Auto Manual)....68

Continuous Sweep/RUN CONT
Initiates a measurement and repeats it continuously until stopped. If necessary, the application automatically determines the reference level before starting the actual measurement.

While the measurement is running, the "Continuous Sweep" softkey and the RUN CONT key are highlighted. The running measurement can be aborted by selecting the highlighted softkey or key again. The results are not deleted until a new measurement is started.

Note: Sequencer. Furthermore, the RUN CONT key controls the Sequencer, not individual sweeps. RUN CONT starts the Sequencer in continuous mode.
For details on the Sequencer, see the R&S FSWP User Manual.

Remote command:
`INITiate<n>:CONTinuous` on page 137

Single Sweep/ RUN SINGLE
Initiates a single measurement. The measurement is finished after all frequencies in the frequency list have been measured. If necessary, the application automatically determines the reference level before starting the actual measurement.

While the measurement is running, the "Single Sweep" softkey and the RUN SINGLE key are highlighted. The running measurement can be aborted by selecting the highlighted softkey or key again.

Note: Sequencer. Furthermore, the RUN SINGLE key controls the Sequencer, not individual sweeps. RUN SINGLE starts the Sequencer in single mode.
If the Sequencer is off, only the evaluation for the currently displayed measurement channel is updated.

For details on the Sequencer, see the R&S FSWP User Manual.

Remote command:
`INITiate<n>[:IMMediate]` on page 137

Calibrate
Initiates a calibration measurement.

For more information see chapter 4.6, "Calibration (2nd Stage Correction)", on page 33.

Remote command:
`INITiate<n>[:IMMediate]` on page 137
when `[SENSe:]CONFigure:CORRection` is on.

Sweep Time
Defines the sweep time.

For more information see "Sweep Time" on page 59.

Meas Mode (Auto Manual)
Selects the measurement mode for the hot and cold power measurements.

For more information about the measurement modes see chapter 4.2, "Measurement Modes", on page 26.

In manual measurement mode, the application opens a dialog box when you start a measurement. For more information about its contents see "Performing a manual measurement" on page 26.

Remote command:
`[SENSe:]CONFigure:CONTrol` on page 139
`[SENSe:]CONFigure:MEASurement` on page 139

5.9 Configuring Inputs and Outputs of the R&S FSWP

The application supports several input sources and outputs. These are the same as in Spectrum mode.

For a comprehensive description of the supported input sources refer to the R&S FSWP User Manual.

5.9.1 Radio Frequency (RF) Input

The RF input is the default input of the R&S FSWP.

Input Coupling....69
Impedance....69
High-Pass Filter 1...3 GHz....69
YIG-Preselector....70

Input Coupling
The RF input of the R&S FSWP can be coupled by alternating current (AC) or direct current (DC).

AC coupling blocks any DC voltage from the input signal. This is the default setting to prevent damage to the instrument. Very low frequencies in the input signal may be distorted.

However, some specifications require DC coupling. In this case, you must protect the instrument from damaging DC input voltages manually. For details, refer to the data sheet.

Remote command:
`INPut:COUPling` on page 141

Impedance
For some measurements, the reference impedance for the measured levels of the R&S FSWP can be set to 50 Ω or 75 Ω.

75 Ω should be selected if the 50 Ω input impedance is transformed to a higher impedance using a 75 Ω adapter of the RAZ type (= 25 Ω in series to the input impedance of the instrument). The correction value in this case is 1.76 dB = 10 log (75Ω/50Ω).

This value also affects the unit conversion.

Remote command:
`INPut:IMPedance` on page 141

High-Pass Filter 1...3 GHz
Activates an additional internal high-pass filter for RF input signals from 1 GHz to 3 GHz. This filter is used to remove the harmonics of the analyzer in order to measure the harmonics for a DUT, for example.

This function requires an additional hardware option.

(Note: for RF input signals outside the specified range, the high-pass filter has no effect. For signals with a frequency of approximately 4 GHz upwards, the harmonics are suppressed sufficiently by the YIG filter.)

Remote command:
`INPut:FILTer:HPASs[:STATe]` on page 141

YIG-Preselector
Activates or deactivates the YIG-preselector, if available on the R&S FSWP.

An internal YIG-preselector at the input of the R&S FSWP ensures that image frequencies are rejected. However, this is only possible for a restricted bandwidth. In order to use the maximum bandwidth for signal analysis you can deactivate the YIG-preselector at the input of the R&S FSWP, which may lead to image-frequency display.

Note that the YIG-preselector is active only on frequencies greater than 8 GHz. Therefore, switching the YIG-preselector on or off has no effect if the frequency is below that value.

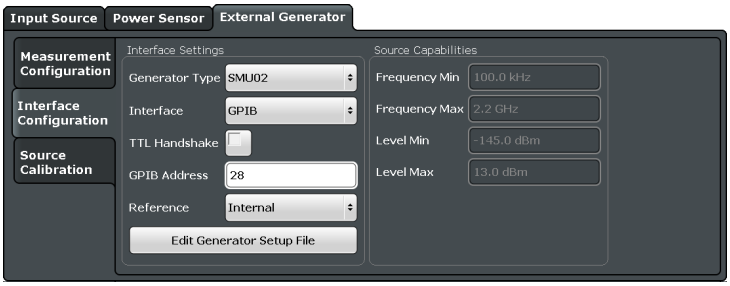
Remote command:
`INPut:FILTer:YIG[:STATe]` on page 142

5.9.2 External Generator

- Interface Configuration Settings....70
- Measurement Configuration....72

5.9.2.1 Interface Configuration Settings

The interface settings for the connection to the external generator are defined in the "Interface Configuration" subtab of the "External Generator" tab.



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Interface....70
TTL Handshake....71
GPIB Address / TCP/IP Address....71
Reference....71
Edit Generator Setup File....71
Frequency Min. / Frequency Max....71
Level Min. / Level Max....71

Generator Type
Selects the generator type and thus defines the generator setup file to use.

Remote command:
`SYSTem:COMMunicate:RDEVice:GENerator:TYPE` on page 144

Interface
Type of interface connection used. The following interfaces are currently supported:

- GPIB
- TCP/IP (not by all generators)

For details on which signal generators support which interfaces, see the documentation of the corresponding signal generator.

Remote command:
`SYSTem:COMMunicate:RDEVice:GENerator:INTerface` on page 144

TTL Handshake
Turning the TTL handshake on and off has no effect for Noise Figure measurements.

GPIB Address / TCP/IP Address
For LAN connections: TCP/IP address of the signal generator

For GPIB connections: GPIB address of the signal generator.

Remote command:
`SYSTem:COMMunicate:GPIB:RDEVice:GENerator:ADDRess` on page 144
`SYSTem:COMMunicate:TCPip:RDEVice:GENerator:ADDRess` on page 145

Reference
Selects the internal R&S FSWP or an external frequency reference to synchronize the R&S FSWP with the generator (default: internal).

Remote command:
`SOURce:EXTernal:ROSCillator[:SOURce]` on page 144

Edit Generator Setup File
Displays the setup file for the currently selected Generator Type in read-only mode in an editor.

Although the existing setup files are displayed in read-only mode in the editor, they can be saved under a different name (using "File > SaveAs").

For more information see chapter 4.4, "External Generator Control", on page 29.

Frequency Min. / Frequency Max.
For reference only: Lower and upper frequency limit for the generator.

Level Min. / Level Max.
For reference only: Lower and upper power limit for the generator.

5.9.2.2 Measurement Configuration

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Init Before Meas....72
Auto Switch Off....73
Source Power....73
Frequency Coupling....73
Init External Generator....74

Automatic Control
Turns automatic control of the external generator on and off.

If on, the application controls the configuration of the external generator during measurements by transmitting the required remote commands. The connection is established automatically before a measurement if Init Before Meas is on. To establish the connection manually at any time, use the Init External Generator function.

Otherwise, you have to control the generator manually. The application assumes that the generator is configured correctly for the measurement. The remote connection to the generator is automatically terminated.

Note that you have to turn automatic control on if you want to perform Fixed IF measurements in order to keep the LO frequency tuned to the current measurement (RF) frequency. Manual control is recommended only for measurements whose generator settings remain the same during the measurement.

Remote command:
`SYSTem:CONFigure:GENerator:CONTrol:STATe` on page 145

Init Before Meas
Turns automatic transmission of the external generator configuration on and off.

If on, the application transmits a sequence of remote commands that configures the generator and turns on its RF output before each measurement. Configuring the generator this way allows you to make sure that the generator runs with the configuration you need and is in a state to receive remote control commands during a measurement. Using automatic initialization of the generator results in a slightly longer measurement time because of the time required to transmit the commands and configure the generator.

If off, you have to initialize the generator manually with Init External Generator.

Note that you have to establish the connection in order to be able to perform a measurement with the external generator.

Remote command:
SYSTem:CONFigure:GENerator:INITialise:AUTO on page 145

Auto Switch Off
Turns automatic deactivation of the generator's RF output on and off.

If on, the application transmits a sequence of remote commands to turn off the RF output of the generator when a measurement is over. A measurement is over after a single sweep or if the measurement is aborted. The sequence of commands also ends the remote control session.

If off, you have to turn the RF output and remote control session off manually.

Note that exiting the Noise Figure Measurement application always turns off the generator's RF output and terminates the remote session.

Remote command:
SYSTem:CONFigure:GENerator:SWITch:AUTO on page 146

Source Power
Defines the output power of the external generator.

The range depends on the generator you are using and is defined in its data sheet.

Remote command:
SOURce:EXTernal:POWer[:LEVel] on page 143

Frequency Coupling
Defines frequency correction characteristics.

The generator frequency is calculated as follows.

$$f_{Generator} = \left[\left(f_{LO} + Offset\ <1> \right) * \frac{Numerator}{Denominator} \right] + Offset\ <2>$$

with:
- $f_{Generator}$= generator frequency
- f_{LO}= frequency of the analyzer's LO
- $f_{offset<1>}$= offset frequency of the analyzer
- $f_{offset<2>}$= offset frequency of other components

You can use the factors and offsets to compensate one or more components in the test setup that may change the frequency between the generator and the DUT. Make sure, however, that the result does not exceed the frequency range of the generator.

The application calculates the resulting start and stop frequency based on the values you apply and displays them below the equation.

Remote command:
SOURce:EXTernal:FREQuency[:FACTor]:DENominator on page 142
SOURce:EXTernal:FREQuency[:FACTor]:NUMerator on page 142
SOURce:EXTernal:FREQuency:OFFSet<offset> on page 142

Init External Generator
Establishes a connection to generator and turns on its RF output.

You can establish the connection automatically before a measurement if Init Before Meas is on.

Note that you have to establish the connection in order to be able to perform a measurement with the external generator.

Remote command:
`SYSTem:CONFigure:GENerator:INITialise:IMMediate` on page 145

5.9.3 DC Power Output Configuration

The configuration of the DC Power supply is the same as in the Phase Noise application.

For a comprehensive description, please refer to the R&S FSWP User Manual.

5.9.4 Signal Source Output Configuration

The configuration of the optional signal source is the same as in the Phase Noise application.

For a comprehensive description, please refer to the R&S FSWP User Manual.

6 Analysis

This chapter contains all settings and parameters that the application provides to analyze and evaluate measurement results.

- Configuring the Display....75
- Working with Traces....77
- Using Markers....79
- Limit Line Settings and Functions....84

6.1 Configuring the Display

The "Display Configuration" button or the "Result Config" softkey open a dialog box to configure the way the results are displayed in the diagram.

The contents depend on whether you want to configure a graphical result display or a numerical result display.

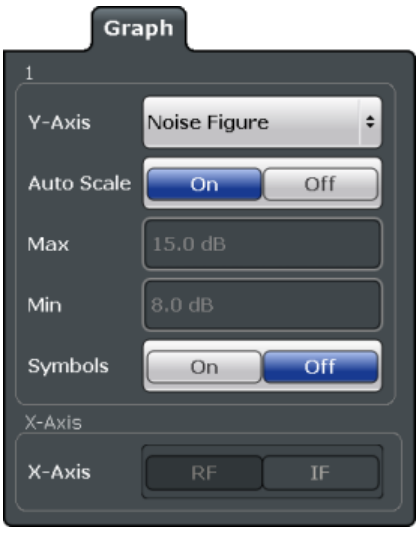
Specifics for

The settings you make apply to the results you have selected in the "Specifics for" dropdown menu. If more than one window is on, "Specifics for" also puts the focus on the corresponding window.

- Configuring Graphical Results....75
- Configuring Numerical Results....77

6.1.1 Configuring Graphical Results

When configuring graphical results, the dialog box contains functionality to scale and set up the diagram axes.



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X-Axis....76

Y-Axis
Selects the result display and thus the scaling of the vertical axis.

For more information see chapter 3, "Measurements and Result Displays", on page 15.

Auto Scale / Min / Max
Turns automatic scaling of the vertical axis on and off.

If on, the application optimizes the scaling of the vertical axis after each measurement for ideal viewing of the results.

If off, you can define the scaling manually. The "Min" and "Max" input fields become available. These two input fields define the values at the top and bottom of the vertical axis.

Remote command:
Automatic scaling:
`DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:AUTO` on page 147
Manual minimum value:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:BOTTom` on page 147
Manual maximum value
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:TOP` on page 148

Symbols
Turns symbols that represent a measurement point on the trace on and off.

Remote command:
`DISPlay[:WINDow<n>]:TRACe:SYMBols` on page 146

Uncertainty
Currently undocumented feature.

X-Axis
Selects the frequency data that is displayed on the x-axis.

For measurements on frequency converting DUTs with a variable intermediary frequency, you can display either the RF frequency or the IF frequency.

Note that a change of the x-axis scale applies to all result displays.

The "Frequency Axis" scale is also available via the FREQ key.

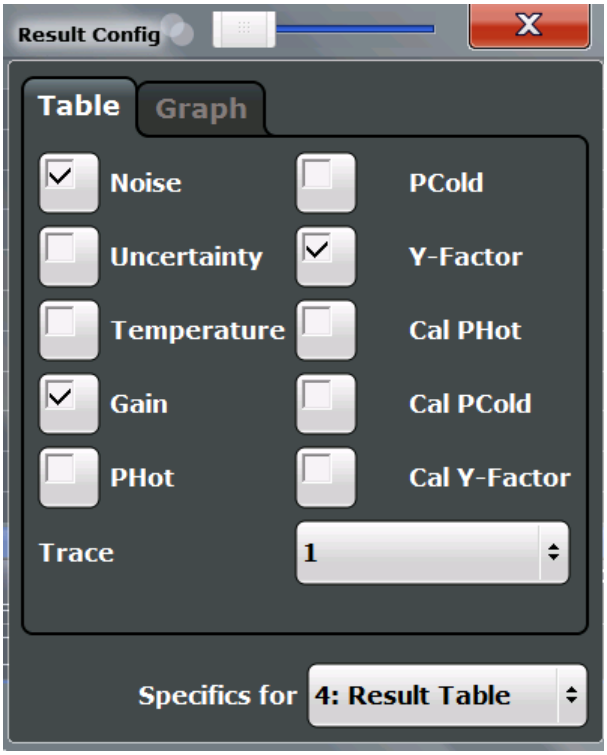
Remote command:
`DISPlay[:WINDow<n>]:TRACe:X[:SCALe]` on page 147

6.1.2 Configuring Numerical Results

When configuring numerical results, the dialog box selects the type of results you want to display in the result table. The results in the table are based on a particular trace that you can select in the corresponding input field.

You can add an aspect of the measurement by placing a checkmark in front of the corresponding result on and remove it by removing the checkmark.

For more information on each result see chapter 3, "Measurements and Result Displays", on page 15.



6.2 Working with Traces

A trace is the graphical representation of a set of measurement results in a diagram. Each measurement window that contains graphical results supports up to four individual traces. Each trace has a different color. Trace settings determine how the measured data is analyzed and displayed on the screen. The trace information, including a color map and trace mode is summarized in the diagram header.

The trace settings are combined in the "Trace Configuration" dialog box. You can access this dialog box with the "Trace Config" softkey or directly access one of the tabs via one of the softkeys in the "Trace" menu.

Traces....78
Copy Trace....78
Preset Traces....78
Trace Config....78
Trace Export....78

Traces
The "Trace 1 to 4" softkeys open the "Traces" tab of the "Trace Configuration" dialog box.

The "Traces" tab contains functionality to configure a trace.

"Trace Selection"	The "Trace 1" to "Trace 4" buttons select a trace. If a trace is selected, it is highlighted orange. Note that you cannot select a trace if its trace mode is "Blank".
"Trace Mode"	Selects the trace mode for the corresponding trace. For more information see chapter 4, "Measurement Basics", on page 24.

Remote command:
Trace mode:
`DISPlay[:WINDow<n>]:TRACe<t>:MODE` on page 149

Copy Trace
Access: "Overview" > "Analysis" > "Traces" > "Copy Trace"

Copies trace data to another trace.

The first group of buttons (labelled "Trace 1" to "Trace 4") select the source trace. The second group of buttons (labelled "Copy to Trace 1" to "Copy to Trace 4") select the destination.

Remote command:
`TRACe<n>:COPY` on page 151

Preset Traces
Restores the default configuration for all traces in a window.

Trace Config
Opens a dialog box made up out of three tabs to configure traces.

The first tab contains functionality to configure a trace. For more information see "Traces" on page 78.

The second tab contains functionality to export trace data. For more information see "Trace Export" on page 78.

The third tab contains functionality to copy traces. For more information see "Copy Trace" on page 78.

Trace Export
The "Trace Export" tab contains functionality to export trace data.

"Export all traces and all table results"	Turns the export of all measurement results (traces and numerical results) on and off. If on, selecting a particular trace to export in the "Trace to Export" dropdown menu is unavailable.
"Include Instrument Measurement Settings"	Includes or excludes the measurement configuration as shown in the channel bar from the export.
"Trace to Export"	Selects the trace that will be exported to a file.
"Decimal Separator"	Selects the decimal separator for floating-point numerals for the ASCII Trace export. Evaluation programs require different separators in different languages.
"Export Trace to ASCII File"	Opens a file selection dialog box and saves the selected trace in ASCII format to the specified file and directory.

Remote command:
Decimal separator:
`FORMat:DEXPort:DSEParator` on page 150
Export trace to ASCII file:
`MMEMory:STORe<n>:TRACe` on page 151
Selecting a trace:
`FORMat:DEXPort:TRACes` on page 151
Export the header:
`FORMat:DEXPort:HEADer` on page 150

6.3 Using Markers

Markers help you to read out measurement results for particular frequencies or mark a particular point on a trace. The noise figure application features four markers. Markers in the noise figure application are linked. If you use more than one measurement window and activate a marker in one window, it also appears in all other measurement windows on the same horizontal position.

- Marker Configuration....79
- Marker Positioning....82

6.3.1 Marker Configuration

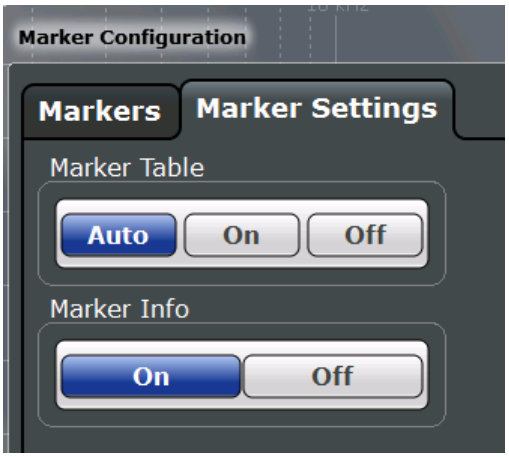
The "Marker Configuration" dialog box and the "Marker" menu contain all functionality necessary to control markers.

You can access the "Marker" menu with the MKR key and the "Marker Configuration" dialog box with the "Marker Config" softkey.

The "Marker Configuration" dialog box consists of two tabs.

The "Markers" tab contains functionlity to define characteristics for each marker.

The "Marker Settings" tab contains general marker functionality.



Marker (1...4) 80
Marker Type 81
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All Markers Off 81
Marker Config 81
Marker Table Display 81
Marker Info 82

Marker (1...4)
Selects or turns the corresponding marker on and off.

Turning on a marker also opens an input field to define the horizontal position of the marker.

By default, the first marker you turn on is a normal marker, all others are delta markers.

Marker Type
Toggles the marker type.

The type for marker 1 is always "Normal", the type for delta marker 1 is always "Delta". These types cannot be changed.

Note: If normal marker 1 is the active marker, switching the "Mkr Type" activates an additional delta marker 1. For any other marker, switching the marker type does not activate an additional marker, it only switches the type of the selected marker.

"Normal" A normal marker indicates the absolute value at the defined position in the diagram.

"Delta" A delta marker defines the value of the marker relative to the specified reference marker (marker 1 by default).

Remote command:
`CALCulate<n>:MARKer<m>[:STATe]` on page 161
`CALCulate<n>:DELTamarker<m>[:STATe]` on page 163

Marker to Trace
Opens an input field to assign the marker to a particular trace if you are using more than one trace.

All Markers Off
Deactivates all markers in one step.

Remote command:
`CALCulate<n>:MARKer<m>:AOFF` on page 160

Marker Config
Opens the "Marker Configuration" dialog box.

The "Marker Configuration" dialog box contains all marker functions necessary to set up the four markers supported by the application.

- Selected
  Highlights the currently selected marker.
- State
  Turns a marker on and off.
- X-value
  Defines the marker position on the horizontal axis.
- Type
  Selects the marker type. For more information see "Marker Type" on page 81.
- Trace
  Selects the trace the marker is positioned on.

Marker Table Display
Defines how the marker information is displayed.

"On" Displays the marker information in a table in a separate area beneath the diagram.

"Off" Displays the marker information within the diagram area.

Remote command:
DISPlay:MTABle on page 166

Marker Info
Turns the marker information displayed in the diagram on and off.

Remote command:
DISPlay:MINFo[:STAT] on page 165

6.3.2 Marker Positioning

If you are using more thn one measurement window, the application performs the peak search in the currently selected measurement window. The currently selected measurement window has a blue border. Because the markers are linked in the noise figure application, the frequency position of the marker in the other window is updated accordingly, even if it means that the marker is on a peak in one window only.

Select Marker <x> 82
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Search Minimum 83
Search Next Minimum 84
Marker to Single Frequency 84

Select Marker <x>
Opens a dialog box to select and activate or deactivate one or more markers.

The number in the softkey label (**<x>**) shows the number of the currently selected marker.

Remote command:
Marker selected via suffix <m> in remote commands.

Peak Search
Sets the selected marker/delta marker to the maximum of the trace. If no marker is active, marker 1 is activated.

Remote command:
CALCulate<n>:MARKer<m>:MAXimum[:PEAK] on page 167
CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK] on page 169

Search Next Peak
Sets the selected marker/delta marker to the next (lower) maximum of the assigned trace. If no marker is active, marker 1 is activated.

Remote command:
CALCulate<n>:MARKer<m>:MAXimum:NEXT on page 167
CALCulate<n>:MARKer<m>:MAXimum:RIGHt on page 167
CALCulate<n>:MARKer<m>:MAXimum:LEFT on page 166
CALCulate<n>:DELTamarker<m>:MAXimum:NEXT on page 168
CALCulate<n>:DELTamarker<m>:MAXimum:RIGHt on page 169
CALCulate<n>:DELTamarker<m>:MAXimum:LEFT on page 168

Search Minimum
Sets the selected marker/delta marker to the minimum of the trace. If no marker is active, marker 1 is activated.

Remote command:
CALCulate<n>:MARKer<m>:MINimum[:PEAK] on page 168
CALCulate<n>:DELTamarker<m>:MINimum[:PEAK] on page 169

Search Next Minimum
Sets the selected marker/delta marker to the next (higher) minimum of the selected trace. If no marker is active, marker 1 is activated.

Remote command:
`CALCulate<n>:MARKer<m>:MINimum:NEXT` on page 167
`CALCulate<n>:MARKer<m>:MINimum:LEFT` on page 167
`CALCulate<n>:MARKer<m>:MINimum:RIGHt` on page 168
`CALCulate<n>:DELTamarker<m>:MINimum:NEXT` on page 169
`CALCulate<n>:DELTamarker<m>:MINimum:LEFT` on page 169
`CALCulate<n>:DELTamarker<m>:MINimum:RIGHt` on page 170

Marker to Single Frequency
Starts a single frequency measurement on the current marker position.

When you use this function, the application changes the tuning mode and automatically adjusts the single frequency to that of the current marker position.

For more information see chapter 4.1.3, "Single Frequency Measurements", on page 25.

6.4 Limit Line Settings and Functions

Access: "Overview" > "Analysis" > "Lines"

The noise figure measurement application supports up to eight active limit lines in each active measurement window.

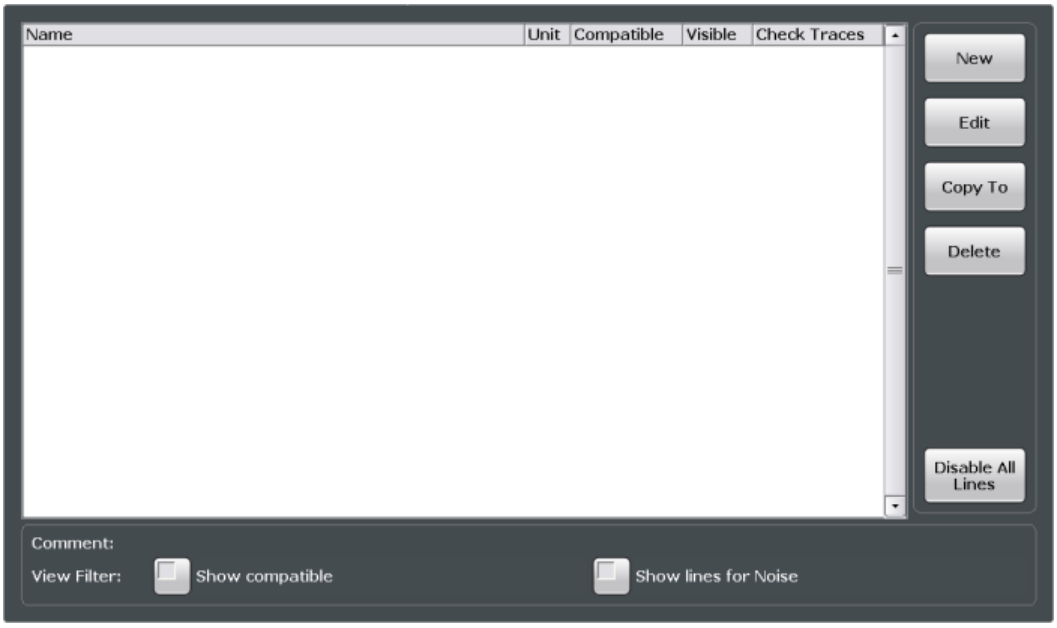
Stored limit line settings
When storing and recalling limit line settings, consider the information provided in the Data Management chapter of the R&S FSWP User Manual.

- Limit Line Management....84
- Limit Line Details....87

6.4.1 Limit Line Management

Access to limit line settings

► "Overview" > "Analysis" > "Lines" > "Limit Lines"



For the limit line overview, the R&S FSWP searches for all stored limit lines with the file extension `.LIN` in the `limits` subfolder of the main installation folder. The overview allows you to determine which limit lines are available and can be used for the current measurement.

For details on settings for individual lines see chapter 6.4.2, "Limit Line Details", on page 87.

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Traces to be Checked....86
Comment....86
Show compatible limit lines....86
Show lines for noise....86
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Delete Line....86
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Name
The name of the stored limit line.

Unit
The unit in which the y-values of the data points of the limit line are defined.

Compatibility
Indicates whether the limit line definition is compatible with the current measurement settings.

Visibility
Displays or hides the limit line in the diagram. Up to 8 limit lines can be visible at the same time. Inactive limit lines can also be displayed in the diagram.

Remote command:
CALCulate<n>:LIMit<k>:LOWer:STATe on page 156
CALCulate<n>:LIMit<k>:UPPer:STATe on page 157
CALCulate<n>:LIMit<k>:ACTive? on page 157

Traces to be Checked
Defines which traces are automatically checked for conformance with the limit lines. As soon as a trace to be checked is defined, the assigned limit line is active. One limit line can be activated for several traces simultaneously. If any of the "Traces to be Checked" violate any of the active limit lines, a message is indicated in the diagram.

Remote command:
CALCulate<n>:LIMit<k>:TRACe<t>:CHECk on page 160

Comment
An optional description of the limit line.

Show compatible limit lines
Defines which of the stored limit lines are included in the overview.

If active, only limit lines that are compatible to the result display currently in focus are displayed.

Show lines for noise
If activated (default), only limit lines created for noise figure measurements are displayed. Otherwise, all limit lines are displayed.

Create New Line
Creates a new limit line.

Edit Line
Edit an existing limit line configuration.

Copy Line
Copy the selected limit line configuration to create a new line.

Remote command:
CALCulate<n>:LIMit<k>:COPY on page 158

Delete Line
Delete the selected limit line configuration.

Remote command:
CALCulate<n>:LIMit<k>:DELete on page 158

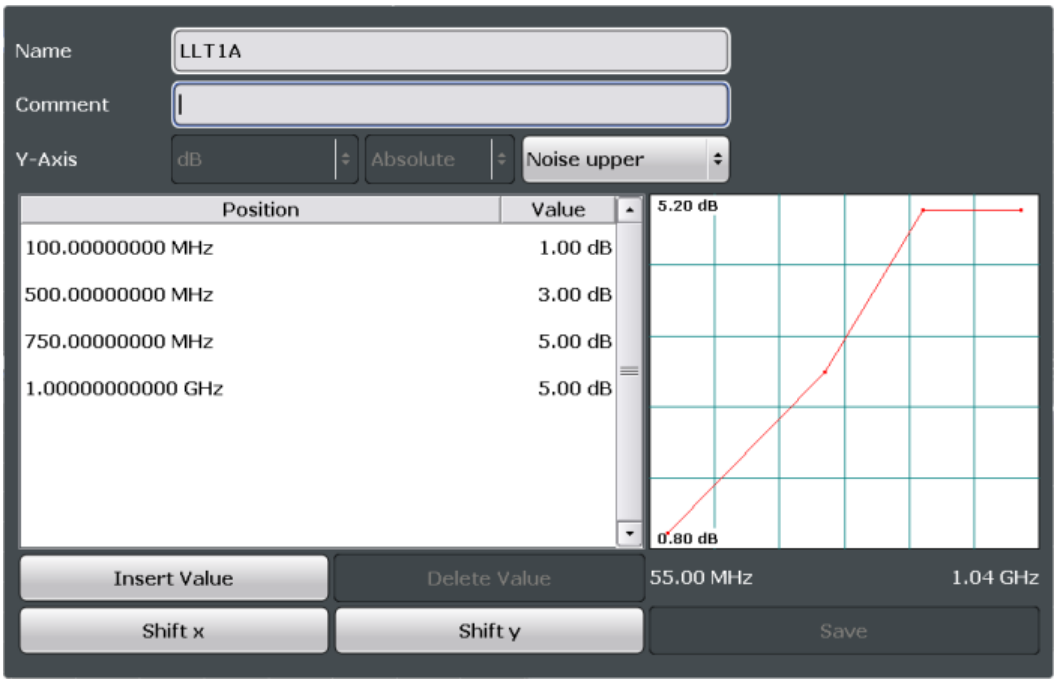
Disable All Lines
Disable all limit lines in one step.

Remote command:
CALCulate<n>:LIMit<k>:STATe on page 159

6.4.2 Limit Line Details

Access to limit line design

► "Overview" > "Analysis" > "Lines" > "Limit Lines" > "New" / "Edit" / "Copy To"



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Comment....87
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Save....88

Name
Defines the limit line name. All names must be compatible with Windows conventions for file names. The limit line data is stored under this name (with a `.LIN` extension).

Remote command:
`CALCulate<n>:LIMit<k>:NAME` on page 153

Comment
Defines an optional comment for the limit line. The text may contain up to 40 characters.

Remote command:
`CALCulate<n>:LIMit<k>:COMMent` on page 153

Y-Axis
Describes the vertical axis on which the data points of the limit line are defined.

You can select the type of limit line (upper or lower) for each type of result. From that information, the application sets the level unit and y-axis scaling. Both are then fix parameters because the unit depends on the result and the scaling is always absolute in case of noise figure measurements.

Data points
Each limit line is defined by a minimum of 2 and a maximum of 200 data points. Each data point is defined by its position (x-axis) and value (y-value). Data points must be defined in ascending order. The same position can have two different values.

Remote command:
`CALCulate<n>:LIMit<k>:CONTrol[:DATA]` on page 154
`CALCulate<n>:LIMit<k>:LOWer[:DATA]` on page 155
`CALCulate<n>:LIMit<k>:UPPer[:DATA]` on page 156

Insert Value
Inserts a data point in the limit line above the selected one in the "Edit Limit Line" dialog box.

Delete Value
Deletes the selected data point in the "Edit Limit Line" dialog box.

Shift x
Shifts the x-value of each data point horizontally by the defined shift width.

Remote command:
`CALCulate<n>:LIMit<k>:CONTrol:SHIFt` on page 155

Shift y
Shifts the y-value of each data point vertically by the defined shift width.

Remote command:
`CALCulate<n>:LIMit<k>:LOWer:SHIFt` on page 156
`CALCulate<n>:LIMit<k>:UPPer:SHIFt` on page 157

Save
Saves the currently edited limit line under the name defined in the "Name" field.

7 Remote Control Commands for Noise Measurements

The following remote control commands are required to configure and perform noise figure measurements in a remote environment. The R&S FSWP must already be set up for remote operation in a network as described in the base unit manual.

Universal functionality

Note that basic tasks that are also performed in the base unit in the same way are not described here. For a description of such tasks, see the R&S FSWP User Manual.

In particular, this includes:

- Managing Settings and Results, i.e. storing and loading settings and result data.
- Basic instrument configuration, e.g. checking the system configuration, customizing the screen layout, or configuring networks and remote operation.
- Using the common status registers (specific status registers for Pulse measurements are not used).

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7.1 Overview of Remote Command Suffixes

The remote commands for the Noise Figure Measurement application support the following suffixes.

Suffix	Value range	Description
<k>	1...8	Selects a limit line.
<m>	1...4	Selects a marker or delta marker.
<n>	1...16	Selects a measurement window.
<t>	1...4	Selects a trace.

7.2 Introduction

Commands are program messages that a controller (e.g. a PC) sends to the instrument or software. They operate its functions ('setting commands' or 'events') and request information ('query commands'). Some commands can only be used in one way, others work in two ways (setting and query). If not indicated otherwise, the commands can be used for settings and queries.

The syntax of a SCPI command consists of a header and, in most cases, one or more parameters. To use a command as a query, you have to append a question mark after the last header element, even if the command contains a parameter.

A header contains one or more keywords, separated by a colon. Header and parameters are separated by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, e.g. blank). If there is more than one parameter for a command, these are separated by a comma from one another.

Only the most important characteristics that you need to know when working with SCPI commands are described here. For a more complete description, refer to the User Manual of the R&S FSWP.

Remote command examples

Note that some remote command examples mentioned in this general introduction may not be supported by this particular application.

7.2.1 Conventions used in Descriptions

Note the following conventions used in the remote command descriptions:

- **Command usage**
  If not specified otherwise, commands can be used both for setting and for querying parameters.
  If a command can be used for setting or querying only, or if it initiates an event, the usage is stated explicitely.
- **Parameter usage**
  If not specified otherwise, a parameter can be used to set a value and it is the result of a query.
  Parameters required only for setting are indicated as **Setting parameters**.
  Parameters required only to refine a query are indicated as **Query parameters**.

Parameters that are only returned as the result of a query are indicated as **Return values**.

- **Conformity**
  Commands that are taken from the SCPI standard are indicated as **SCPI confirmed**. All commands used by the R&S FSWP follow the SCPI syntax rules.
- **Asynchronous commands**
  A command which does not automatically finish executing before the next command starts executing (overlapping command) is indicated as an **Asynchronous command**.
- **Reset values (*RST)**
  Default parameter values that are used directly after resetting the instrument (`*RST` command) are indicated as ***RST** values, if available.
- **Default unit**
  This is the unit used for numeric values if no other unit is provided with the parameter.
- **Manual operation**
  If the result of a remote command can also be achieved in manual operation, a link to the description is inserted.

7.2.2 Long and Short Form

The keywords have a long and a short form. You can use either the long or the short form, but no other abbreviations of the keywords.

The short form is emphasized in upper case letters. Note however, that this emphasis only serves the purpose to distinguish the short from the long form in the manual. For the instrument, the case does not matter.

Example:

`SENSe:FREQuency:CENTer` is the same as `SENS:FREQ:CENT`.

7.2.3 Numeric Suffixes

Some keywords have a numeric suffix if the command can be applied to multiple instances of an object. In that case, the suffix selects a particular instance (e.g. a measurement window).

Numeric suffixes are indicated by angular brackets (<n>) next to the keyword.

If you don't quote a suffix for keywords that support one, a 1 is assumed.

Example:

`DISPlay[:WINDow<1...4>]:ZOOM:STATe` enables the zoom in a particular measurement window, selected by the suffix at `WINDow`.

`DISPlay:WINDow4:ZOOM:STATe ON` refers to window 4.

7.2.4 Optional Keywords

Some keywords are optional and are only part of the syntax because of SCPI compliance. You can include them in the header or not.

Note that if an optional keyword has a numeric suffix and you need to use the suffix, you have to include the optional keyword. Otherwise, the suffix of the missing keyword is assumed to be the value 1.

Optional keywords are emphasized with square brackets.

Example:

Without a numeric suffix in the optional keyword:

`[SENSe:]FREQuency:CENTer` is the same as `FREQuency:CENTer`

With a numeric suffix in the optional keyword:

`DISPlay[:WINDow<1...4>]:ZOOM:STATe`

`DISPlay:ZOOM:STATe ON` enables the zoom in window 1 (no suffix).

`DISPlay:WINDow4:ZOOM:STATe ON` enables the zoom in window 4.

7.2.5 Alternative Keywords

A vertical stroke indicates alternatives for a specific keyword. You can use both keywords to the same effect.

Example:

`[SENSe:]BANDwidth|BWIDth[:RESolution]`

In the short form without optional keywords, `BAND 1MHZ` would have the same effect as `BWID 1MHZ`.

7.2.6 SCPI Parameters

Many commands feature one or more parameters.

If a command supports more than one parameter, these are separated by a comma.

Example:

```
LAYout:ADD:WINDow Spectrum,LEFT,MTABle
```

Parameters may have different forms of values.

- Numeric Values....93
- Boolean....93
- Character Data....94
- Character Strings....94
- Block Data....94

7.2.6.1 Numeric Values

Numeric values can be entered in any form, i.e. with sign, decimal point or exponent. In case of physical quantities, you can also add the unit. If the unit is missing, the command uses the basic unit.

Example:

with unit: `SENSe:FREQuency:CENTer 1GHZ`

without unit: `SENSe:FREQuency:CENTer 1E9` would also set a frequency of 1 GHz.

Values exceeding the resolution of the instrument are rounded up or down.

If the number you have entered is not supported (e.g. in case of discrete steps), the command returns an error.

Instead of a number, you can also set numeric values with a text parameter in special cases.

- MIN/MAX
  Defines the minimum or maximum numeric value that is supported.
- DEF
  Defines the default value.
- UP/DOWN
  Increases or decreases the numeric value by one step. The step size depends on the setting. In some cases you can customize the step size with a corresponding command.

Querying numeric values

When you query numeric values, the system returns a number. In case of physical quantities, it applies the basic unit (e.g. Hz in case of frequencies). The number of digits after the decimal point depends on the type of numeric value.

Example:

Setting: `SENSe:FREQuency:CENTer 1GHZ`

Query: `SENSe:FREQuency:CENTer?` would return `1E9`

In some cases, numeric values may be returned as text.

- INF/NINF
  Infinity or negative infinity. Represents the numeric values 9.9E37 or -9.9E37.
- NAN
  Not a number. Represents the numeric value 9.91E37. NAN is returned in case of errors.

7.2.6.2 Boolean

Boolean parameters represent two states. The "ON" state (logically true) is represented by "ON" or a numeric value 1. The "OFF" state (logically untrue) is represented by "OFF" or the numeric value 0.

Querying boolean parameters

When you query boolean parameters, the system returns either the value 1 ("ON") or the value 0 ("OFF").

Example:

Setting: `DISPlay:WINDow:ZOOM:STATe ON`

Query: `DISPlay:WINDow:ZOOM:STATe?` would return `1`

7.2.6.3 Character Data

Character data follows the syntactic rules of keywords. You can enter text using a short or a long form. For more information see chapter 7.2.2, "Long and Short Form", on page 91.

Querying text parameters

When you query text parameters, the system returns its short form.

Example:

Setting: `SENSe:BANDwidth:RESolution:TYPE NORMal`

Query: `SENSe:BANDwidth:RESolution:TYPE?` would return `NORM`

7.2.6.4 Character Strings

Strings are alphanumeric characters. They have to be in straight quotation marks. You can use a single quotation mark (') or a double quotation mark (").

Example:

```
INSTRument:DELete 'Spectrum'
```

7.2.6.5 Block Data

Block data is a format which is suitable for the transmission of large amounts of data.

The ASCII character # introduces the data block. The next number indicates how many of the following digits describe the length of the data block. In the example the 4 following digits indicate the length to be 5168 bytes. The data bytes follow. During the transmission of these data bytes all end or other control signs are ignored until all bytes are transmitted. #0 specifies a data block of indefinite length. The use of the indefinite format requires a NL^END message to terminate the data block. This format is useful when the length of the transmission is not known or if speed or other considerations prevent segmentation of the data into blocks of definite length.

7.3 Controlling the Noise Figure Measurement Channel

The following commands are necessary to control the measurement channel.

INSTrument:CREate:DUPLicate 95
INSTrument:CREate[:NEW] 95
INSTrument:CREate:REPLace 96
INSTrument:DELete 96
INSTrument:LIST? 96
INSTrument:REName 97
INSTrument[:SELect] 97
SYSTem:PRESet:CHANnel[:EXECute] 98

INSTrument:CREate:DUPLicate

This command duplicates the currently selected measurement channel, i.e creates a new measurement channel of the same type and with the identical measurement settings. The name of the new channel is the same as the copied channel, extended by a consecutive number (e.g. "IQAnalyzer" -> "IQAnalyzer2").

The channel to be duplicated must be selected first using the `INST:SEL` command.

Example:
```
INST:SEL 'PhaseNoise'
INST:CRE:DUPL
```
Duplicates the channel named 'PhaseNoise' and creates a new measurement channel named 'PhaseNoise 2'.

Usage: Event

INSTrument:CREate[:NEW] <ChannelType>, <ChannelName>

This command adds an additional measurement channel.

The number of measurement channels you can configure at the same time depends on available memory.

Parameters:

<ChannelType> Channel type of the new channel.
For a list of available channel types see `INSTrument:LIST?` on page 96.

<ChannelName> String containing the name of the channel. The channel name is displayed as the tab label for the measurement channel.
Note: If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel (see `INSTrument:LIST?` on page 96).

Example:
```
INST:CRE PNO, 'PhaseNoise 2'
```
Adds an additional phase noise display named "PhaseNoise 2".

INSTrument:CREate:REPLace <ChannelName1>,<ChannelType>,<ChannelName2>

This command replaces a measurement channel with another one.

Setting parameters:

<ChannelName1> String containing the name of the measurement channel you want to replace.

<ChannelType> Channel type of the new channel.
For a list of available channel types see `INSTrument:LIST?` on page 96.

<ChannelName2> String containing the name of the new channel.
Note: If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel (see `INSTrument:LIST?` on page 96).

Example: `INST:CRE:REPL 'PhaseNoise',PNO,'PNO2'`
Replaces the channel named 'PhaseNoise' by a new measurement channel of type 'Phase Noise' named 'PNO2'.

Usage: Setting only

INSTrument:DELete <ChannelName>

This command deletes a measurement channel.

If you delete the last measurement channel, the default "Phase Noise" channel is activated.

Parameters:

<ChannelName> String containing the name of the channel you want to delete.
A measurement channel must exist in order to be able delete it.

Example: `INST:DEL 'PhaseNoise'`
Deletes the channel with the name 'PhaseNoise'.

Usage: Event

INSTrument:LIST?

This command queries all active measurement channels. This is useful in order to obtain the names of the existing measurement channels, which are required in order to replace or delete the channels.

Return values:

<ChannelType>, <ChannelName> For each channel, the command returns the channel type and channel name (see tables below).
Tip: to change the channel name, use the `INSTrument:REName` command.

Example: `INST:LIST?`
Result for 2 measurement channels:
`'PNO','PhaseNoise','PNO','PhaseNoise2'`

Usage: Query only

Table 7-1: Available measurement channel types and default channel names

Application	<ChannelType> Parameter	Default Channel Name*)
Phase Noise	PNOISE	Phase Noise
Spectrum (R&S FSWP-B1)	SANALYZER	Spectrum
I/Q Analyzer (R&S FSWP-B1)	IQ	IQ Analyzer
Analog Demodulation (R&S FSWP-K7)	ADEM	Analog Demod
Noise Figure Measurements (R&S FSWP-K30)	NOISE	Noise
Note: the default channel name is also listed in the table. If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel.		

INSTrument:REName <ChannelName1>, <ChannelName2>

This command renames a measurement channel.

Parameters:

<ChannelName1> String containing the name of the channel you want to rename.

<ChannelName2> String containing the new channel name.
Note that you can not assign an existing channel name to a new channel; this will cause an error.

Example: `INST:REN 'PhaseNoise','PNO'`
Renames the channel with the name PhaseNoise' to 'PNO'.

Usage: Setting only

INSTrument[:SELect] <ChannelType> | <ChannelName>

This command activates a new measurement channel with the defined channel type, or selects an existing measurement channel with the specified name.

Also see

- `INSTrument:CREate[:NEW]` on page 95

Parameters:

<ChannelType> Channel type of the new channel.
For a list of available channel types see `INSTrument:LIST?` on page 96.

<ChannelName> String containing the name of the channel.

Example: `INST IQ`
Activates a measurement channel for the I/Q Analyzer application (evaluation mode).
`INST 'MyIQSpectrum'`
Selects the measurement channel named 'MyIQSpectrum' (for example before executing further commands for that channel).

Usage: SCPI confirmed

SYSTem:PRESet:CHANnel[:EXECute]

This command restores the default instrument settings in the current channel.

Use `INST:SEL` to select the channel.

Example: `INST 'Spectrum2'`
Selects the channel for "Spectrum2".
`SYST:PRES:CHAN:EXEC`
Restores the factory default settings to the "Spectrum2" channel.

Usage: Event

Manual operation: See "Preset Channel" on page 41

7.4 Working with Windows in the Display

The following commands are required to change the evaluation type and rearrange the screen layout for a measurement channel as you do using the SmartGrid in manual operation. Since the available evaluation types depend on the selected application, some parameters for the following commands also depend on the selected measurement channel.

LAYout:ADD[:WINDow]?....98
LAYout:CATalog[:WINDow]?....100
LAYout:IDENtify[:WINDow]?....100
LAYout:REMove[:WINDow]....101
LAYout:REPLace[:WINDow]....101
LAYout:SPLitter....101
LAYout:WINDow<n>:ADD?....103
LAYout:WINDow<n>:IDENtify?....103
LAYout:WINDow<n>:REMove....103
LAYout:WINDow<n>:REPLace....104

LAYout:ADD[:WINDow]? <WindowName>,<Direction>,<WindowType>

This command adds a window to the display in the active measurement channel.

This command is always used as a query so that you immediately obtain the name of the new window as a result.

To replace an existing window, use the `LAYout:REPLace[:WINDow]` command.

Parameters:

<WindowName> String containing the name of the existing window the new window is inserted next to.
By default, the name of a window is the same as its index. To determine the name and index of all active windows, use the `LAYout:CATalog[:WINDow]?` query.

<Direction> LEFT | RIGHt | ABOVe | BELow

Direction the new window is added relative to the existing window.

<WindowType> text value

Type of result display (evaluation method) you want to add.
See the table below for available parameter values.

Return values:

<NewWindowName> When adding a new window, the command returns its name (by default the same as its number) as a result.

Example:

```
LAY:ADD? '1',LEFT,MTAB
```

Result:

```
'2'
```

Adds a new window named '2' with a marker table to the left of window 1.

Usage: Query only

Manual operation:

See "Noise Figure" on page 16
See "Gain" on page 17
See "Noise Temperature" on page 17
See "Y-Factor" on page 18
See "Power (Hot)" on page 19
See "Power (Cold)" on page 19
See "Cal Y-Factor" on page 20
See "Cal Power (Hot)" on page 21
See "Cal Power (Cold)" on page 21
See "Result Table" on page 21
See "Marker Table" on page 22

Table 7-2: <WindowType> parameter values for Noise Figure application

Parameter value	Window type
CPCold	Cal Power (Cold)
CPHot	Cal Power (Hot)
CYFactor	Cal Y-Factor
GAIN	Gain result display
MTABle	Marker table
NOISe	Noise figure result display
PCOLd	Power cold result display
PHOT	Power hot result display

Parameter value	Window type
RESults	Result table
TEMPerature	Noise temperature result display
YFACtor	Y-Factor result display

LAYout:CATalog[:WINDow]?

This command queries the name and index of all active windows in the active measurement channel from top left to bottom right. The result is a comma-separated list of values for each window, with the syntax:

<WindowName_1>,<WindowIndex_1>..<WindowName_n>,<WindowIndex_n>

Return values:

<WindowName> string

Name of the window.
In the default state, the name of the window is its index.

<WindowIndex> **numeric value**
Index of the window.

Example: `LAY:CAT?`
Result:
`'2',2,'1',1`
Two windows are displayed, named '2' (at the top or left), and '1' (at the bottom or right).

Usage: Query only

LAYout:IDENtify[:WINDow]? <WindowName>

This command queries the **index** of a particular display window in the active measurement channel.

Note: to query the **name** of a particular window, use the `LAYout:WINDow<n>:IDENtify?` query.

Query parameters:

<WindowName> String containing the name of a window.

Return values:

<WindowIndex> Index number of the window.

Example: `LAY:WIND:IDEN? '2'`
Queries the index of the result display named '2'.
Response:
`2`

Usage: Query only

LAYout:REMove[:WINDow] <WindowName>

This command removes a window from the display in the active measurement channel.

Parameters:

<WindowName> String containing the name of the window.
In the default state, the name of the window is its index.

Example: `LAY:REM '2'`
Removes the result display in the window named '2'.

Usage: Event

LAYout:REPLace[:WINDow] <WindowName>,<WindowType>

This command replaces the window type (for example from "Diagram" to "Result Summary") of an already existing window in the active measurement channel while keeping its position, index and window name.

To add a new window, use the `LAYout:ADD[:WINDow]?` command.

Parameters:

<WindowName> String containing the name of the existing window.
By default, the name of a window is the same as its index. To determine the name and index of all active windows in the active measurement channel, use the `LAYout:CATalog[:WINDow]?` query.

<WindowType> Type of result display you want to use in the existing window.
See `LAYout:ADD[:WINDow]?` on page 98 for a list of available window types.

Example: `LAY:REPL:WIND '1',MTAB`
Replaces the result display in window 1 with a marker table.

LAYout:SPLitter <Index1>,<Index2>,<Position>

This command changes the position of a splitter and thus controls the size of the windows on each side of the splitter.

Compared to the `DISPlay[:WINDow<n>]:SIZE` on page 105 command, the `LAYout:SPLitter` changes the size of all windows to either side of the splitter permanently, it does not just maximize a single window temporarily.

Note that windows must have a certain minimum size. If the position you define conflicts with the minimum size of any of the affected windows, the command will not work, but does not return an error.

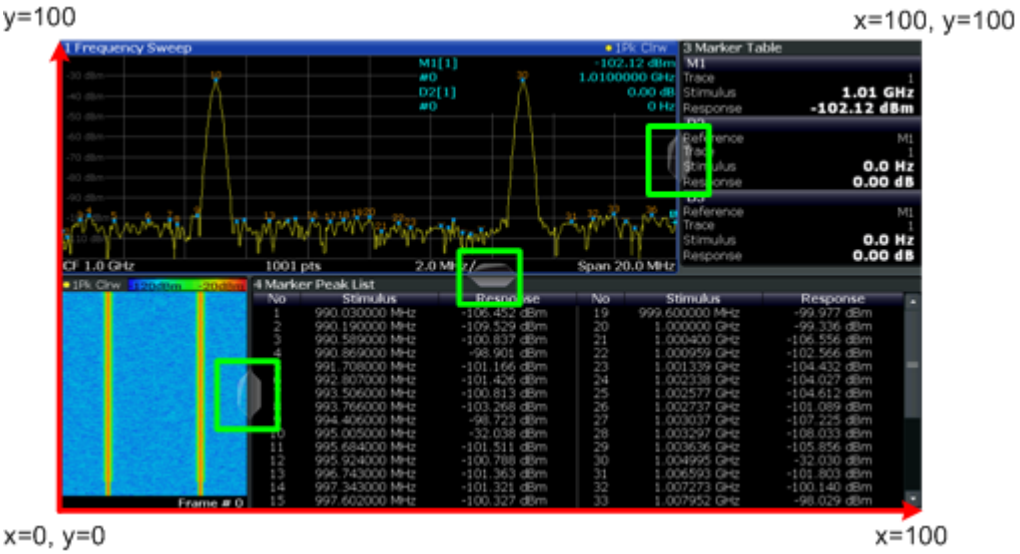

Fig. 7-1: SmartGrid coordinates for remote control of the splitters

Parameters:

<Index1> The index of one window the splitter controls.

<Index2> The index of a window on the other side of the splitter.

<Position> New vertical or horizontal position of the splitter as a fraction of the screen area (without channel and status bar and softkey menu).
The point of origin (x = 0, y = 0) is in the lower left corner of the screen. The end point (x = 100, y = 100) is in the upper right corner of the screen. (See figure 7-1.)
The direction in which the splitter is moved depends on the screen layout. If the windows are positioned horizontally, the splitter also moves horizontally. If the windows are positioned vertically, the splitter also moves vertically.

Range: 0 to 100

Example: `LAY:SPL 1,3,50`
Moves the splitter between window 1 ('Frequency Sweep') and 3 ('Marker Table') to the center (50%) of the screen, i.e. in the figure above, to the left.

Example: `LAY:SPL 1,4,70`
Moves the splitter between window 1 ('Frequency Sweep') and 3 ('Marker Peak List') towards the top (70%) of the screen.
The following commands have the exact same effect, as any combination of windows above and below the splitter moves the splitter vertically.

```
LAY:SPL 3,2,70
LAY:SPL 4,1,70
LAY:SPL 2,1,70
```

LAYout:WINDow<n>:ADD? <Direction>,<WindowType>

This command adds a measurement window to the display. Note that with this command, the suffix <n> determines the existing window next to which the new window is added, as opposed to `LAYout:ADD[:WINDow]?`, for which the existing window is defined by a parameter.

To replace an existing window, use the `LAYout:WINDow<n>:REPLace` command.

This command is always used as a query so that you immediately obtain the name of the new window as a result.

Parameters:

<Direction> LEFT | RIGHt | ABOVe | BELow

<WindowType> Type of measurement window you want to add.
See `LAYout:ADD[:WINDow]?` on page 98 for a list of available window types.

Return values:

<NewWindowName> When adding a new window, the command returns its name (by default the same as its number) as a result.

Example:
```
LAY:WIND1:ADD? LEFT,MTAB
```
Result:
```
'2'
```
Adds a new window named '2' with a marker table to the left of window 1.

Usage: Query only

LAYout:WINDow<n>:IDENtify?

This command queries the **name** of a particular display window (indicated by the <n> suffix) in the active measurement channel.

Note: to query the **index** of a particular window, use the `LAYout:IDENtify[:WINDow]?` command.

Return values:

<WindowName> String containing the name of a window.
In the default state, the name of the window is its index.

Example:
```
LAY:WIND2:IDEN?
```
Queries the name of the result display in window 2.
Response:
```
'2'
```

Usage: Query only

LAYout:WINDow<n>:REMove

This command removes the window specified by the suffix <n> from the display in the active measurement channel.

The result of this command is identical to the `LAYout:REMove[:WINDow]` command.

Example: `LAY:WIND2:REM`
Removes the result display in window 2.

Usage: Event

LAYout:WINDow<n>:REPLace <WindowType>

This command changes the window type of an existing window (specified by the suffix <n>) in the active measurement channel.

The result of this command is identical to the `LAYout:REPLace[:WINDow]` command.

To add a new window, use the `LAYout:WINDow<n>:ADD?` command.

Parameters:

<WindowType> Type of measurement window you want to replace another one with.
See `LAYout:ADD[:WINDow]?` on page 98 for a list of available window types.

Example: `LAY:WIND2:REPL MTAB`
Replaces the result display in window 2 with a marker table.

7.5 General Window Commands

The following commands are required to configure general window layout, independent of the application.

DISPlay:FORMat 104
DISPlay[:WINDow<n>]:SIZE 105

DISPlay:FORMat <Format>

This command determines which tab is displayed.

Parameters:

<Format> **SPLit**
Displays the MultiView tab with an overview of all active channels

SINGle
Displays the measurement channel that was previously focused.

*RST: SING

Example: `DISP:FORM SPL`

DISPlay[:WINDow<n>]:SIZE <Size>

This command maximizes the size of the selected result display window *temporarily*. To change the size of several windows on the screen permanently, use the `LAY:SPL` command (see `LAYout:SPLitter` on page 101).

Parameters:

<Size>

LARGe
Maximizes the selected window to full screen.
Other windows are still active in the background.

SMALl
Reduces the size of the selected window to its original size.
If more than one measurement window was displayed originally, these are visible again.

*RST: SMALl

Example:

```
DISP:WIND2:LARG
```

7.6 Measurement Results

The following commands are necessary to query measurement results.

TRACe<n>[:DATA]? 105

TRACe<n>[:DATA]? <Trace>, <Result>

This command queries the noise measurement results.

Query parameters:

<Trace>

Selects the trace to be read out.

TRACE1

TRACE2

TRACE3

TRACE4

<Result> Selects the result display to be read out.

CPCold
Queries calibration power (cold) results.

CPHot
Queries calibration power (hot) results.

CYFactor
Queries calibration y-factor results.

GAIN
Queries gain reuslts.

NOISe
Queries noise figure results.

NUNCertainty
Queries noise figure uncertainty results.

PCOLd
Queries power (cold) results.

PHOT
Queries power (hot) results.

TEMPerature
Queries noise temperature results.

YFACtor
Queries y-factor results.

Return values:

<TraceData> For any graphical result display, the command returns one result for each measurement point.
The unit depends on the result you are querying.

Example: `TRAC? TRACE1,GAIN`
Queries the gain results for the first trace.

Usage: Query only

Manual operation:
See "Noise Figure" on page 16
See "Gain" on page 17
See "Noise Temperature" on page 17
See "Y-Factor" on page 18
See "Power (Hot)" on page 19
See "Power (Cold)" on page 19
See "Cal Y-Factor" on page 20
See "Cal Power (Hot)" on page 21
See "Cal Power (Cold)" on page 21
See "Result Table" on page 21

7.7 Defining the Measurement Frequency

The following commands are necessary to define the frequency characteristics of the noise figure measurement.

[SENSe:]CONFigure:FREQuency:CONTinuous 107
[SENSe:]CONFigure:FREQuency:SINGle 107
[SENSe:]CONFigure:LIST:CONTinuous 107
[SENSe:]CONFigure:LIST:SINGLe 108
[SENSe:]FREQuency:CENter 108
[SENSe:]FREQuency:LIST:DATA 108
[SENSe:]SWEep:POINts 108
[SENSe:]FREQuency:SINGle 109
[SENSe:]FREQuency:SINGle:COUPling 109
[SENSe:]FREQuency:SPAN 109
[SENSe:]FREQuency:STARt 110
[SENSe:]FREQuency:STEP 110
[SENSe:]FREQuency:STOP 110

[SENSe:]CONFigure:FREQuency:CONTinuous

This command configures the software to perform a single frequency measurement in continuous sweep mode.

Example:
```
FREQ:SING 20MHz
```
Defines a measurement frequency of 20 MHz.
```
CONF:FREQ:CONT
INIT
```
Selects and initiates a single frequency measurement.

Usage: Event

Manual operation: See "Tuning Mode" on page 43

[SENSe:]CONFigure:FREQuency:SINGle

This command configures the software to perform a single frequency measurement in single sweep mode.

Example:
```
FREQ:SING 20MHz
```
Defines a measurement frequency of 20 MHz.
```
CONF:FREQ:SING
INIT
```
Selects and initiates a single frequency measurement.

Usage: Event

Manual operation: See "Tuning Mode" on page 43

[SENSe:]CONFigure:LIST:CONTinuous

This command configures the software to perform a frequency list measurement in continuous sweep mode.

Example:
```
CONF:LIST:CONT
INIT
```
Selects and initiates a frequency list measurement.

Usage: Event

Manual operation: See "Tuning Mode" on page 43

[SENSe:]CONFigure:LIST:SINGLe

This command configures the software to perform a frequency list measurement in single sweep mode.

Example:
```
CONF:LIST:SING
INIT
```
Selects and initiates a single frequency list measurement.

Usage: Event

Manual operation: See "Tuning Mode" on page 43

[SENSe:]FREQuency:CENter <Frequency>

This command defines the center frequency.

Parameters:

<Frequency>
Range: see datasheet
*RST: fmax/2
Default unit: Hz

Example:
```
FREQ:CENT 1GHZ
```
Defines a center frequency of 1 GHz.

Manual operation: See "Center" on page 43

[SENSe:]FREQuency:LIST:DATA <Frequency>

This command defines the contents of a frequency list.

The command overwrites the current contents of the frequency list. The frequency list remains the same until you generate or create a new list.

Parameters:

<Frequency>
Defines a frequency for each entry in the frequency list. A frequency list can contain up to 500 entries.
Range: 0 Hz to fmax

Example:
```
FREQ:LIST:DATA 100MHZ,200MHZ,300MHZ,400MHZ,
500MHZ
```
Creates a frequency list with five entries.

Manual operation: See "Populate Table" on page 47

[SENSe:]SWEep:POINts <SweepPoints>

This command defines the number of measurement points analyzed during a sweep.

Parameters:

<SweepPoints> Range: 1 to 500
*RST: 20

Example: `SWE:POIN 100`
Defines 100 measurement points.

Manual operation: See "(Measurement) Points" on page 44
See "(Measurement) Points" on page 46

[SENSe:]FREQuency:SINGle <Frequency>

This command defines the frequency for single frequency measurements.

Parameters:

<Frequency> The minimum and maximum frequency depend on the hardware. Refer to the datasheet for details.
*RST: 100 MHz

Example: `FREQ:SING 200MHZ`
Defines a measurement frequency of 200 MHz.

Manual operation: See "Center" on page 43
See "Single (Frequency)" on page 45

[SENSe:]FREQuency:SINGle:COUPling <State>

This command couples or decouples the frequency to the contents of the sweep list.

Parameters:

<State> **ON**
Only frequencies in the frequency list can be selected for single frequency measurements.
OFF
Any frequency can be defined for single frequency measurements.
*RST: OFF

Example: `FREQ:SING:COUP ON`
Couples single frequency measurements to the frequency list.

Manual operation: See "Coupled to Sweep List" on page 45

[SENSe:]FREQuency:SPAN <Span>

This command defines the frequency span.

If you change the span, the application creates a new frequency list.

Parameters:

<Span> This parameter is ....
*RST: RST value

Example: FREQ:SPAN 500MHZ
Defines a span of 500 MHz.

Manual operation: See "Span" on page 44

[SENSe:]FREQuency:STARt <Frequency>

This command defines the start frequency.

If you change the start frequency, the application creates a new frequency list.

Parameters:
<Frequency> *RST: RST value

Example: FREQ:STAR 900MHZ
Defines a start frequency of 900 MHz.

Manual operation: See "Start and Stop Frequency" on page 44

[SENSe:]FREQuency:STEP <Stepsize>

This command defines the frequency stepsize in the frequency table.

The stepsize corresponds to the distance from one measurement point to another.

If you change the stepsize, the application creates a new frequency list.

Parameters:
<Stepsize> Range: 0 Hz to span
*RST: 100 MHz

Example: FREQ:STEP 100MHZ
Defines a stepsize of 100 MHz.

Manual operation: See "Step" on page 44

[SENSe:]FREQuency:STOP <Frequency>

This command defines the stop frequency.

If you change the stop frequency, the application creates a new frequency list.

Parameters:
<Frequency> *RST: RST value

Example: FREQ:STOP 900MHZ
Defines a stop frequency of 900 MHz.

Manual operation: See "Start and Stop Frequency" on page 44

7.8 Selecting DUT Characteristics

The following commands are necessary to define DUT characteristics.

[SENSe:]CONFigure:MODE:SYSTem:IF:FREQuency....111
[SENSe:]CONFigure:MODE:SYSTem:LO:FREQuency....111
[SENSe:]CONFigure:MODE:DUT....111
[SENSe:]CORRection:IREJection....112

[SENSe:]CONFigure:MODE:SYSTem:IF:FREQuency <Frequency>

This command defines the frequency for DUTs with a fixed IF.

Parameters:

<Frequency>
Range: 0 Hz to 100 GHz
*RST: 10 MHz, if frequency converting mode has been selected

Example: `CONF:MODE:SYST:IF:FREQ 1GHZ`
Defines a fixed IF of 1 GHz.

Manual operation: See "IF Fixed" on page 48

[SENSe:]CONFigure:MODE:SYSTem:LO:FREQuency <LOFrequency>

This command defines the frequency for DUTs with a fixed LO.

Parameters:

<LOFrequency>
Range: 0 Hz to 100 GHz
*RST: 10 MHz, if frequency converting mode has been selected

Example: `CONF:MODE:SYST:LO:FREQ 1GHZ`
Defines afixed LO frequency of 1 GHz.

Manual operation: See "LO Fixed" on page 48

[SENSe:]CONFigure:MODE:DUT <DUTType>

This command selects the type of DUT you are testing.

Parameters:

<DUTType>
AMPLifier
Measurements on fixed frequency DUTs.
DOWNconv
Measurements on down-converting DUTs.
UPConv
Measurements on up-converting DUTs.
*RST: AMPLifier

Example: `CONF:MODE:DUT DOWN`
Selects the measurement mode for a down-converting DUT.

Manual operation: See "Mode" on page 48

[SENSe:]CORRection:IREJection <ImageRejection>

This command defines the image frequency rejection for the DUT.

Parameters:

<ImageRejection> Range: 0 to 999.99
*RST: 999.99
Default unit: dB

Example: `CORR:IREJ 0`
Turns image rejection off.

Manual operation: See "Image Rejection" on page 49

7.9 Configuring the Noise Source

The following commands are necessary to define the noise source characteristics.

[SENSe:]CORRection:ENR:CALibration:SPOT:COLD....112
[SENSe:]CORRection:ENR:CALibration:SPOT:HOT....113
[SENSe:]CORRection:ENR:CALibration:MODE....113
[SENSe:]CORRection:ENR:CALibration:SPOT....113
[SENSe:]CORRection:ENR:CALibration:TABLe:SELect....114
[SENSe:]CORRection:ENR:CALibration:TYPE....114
[SENSe:]CORRection:ENR:COMMon....115
[SENSe:]CORRection:ENR[:MEASurement]:TABLe:DATA....115
[SENSe:]CORRection:ENR[:MEASurement]:TABLe:DELete....115
[SENSe:]CORRection:ENR[:MEASurement]:TABLe:LIST?....116
[SENSe:]CORRection:ENR[:MEASurement]:TABLe:SELect....116
[SENSe:]CORRection:ENR[:MEASurement]:TABLe:TEMPerature[:DATA]....116
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[SENSe:]CORRection:ENR[:MEASurement]:MODE....118
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[SENSe:]CORRection:ENR[:MEASurement]:SPOT:COLD....119
[SENSe:]CORRection:ENR[:MEASurement]:SPOT:HOT....119
[SENSe:]CORRection:TEMPerature....119

[SENSe:]CORRection:ENR:CALibration:SPOT:COLD <Temperature>

This command defines a constant temperature of a resistor not supplied with power (T_{cold}) used during calibration.

The command is available when you have selected a noise source with resistor characteristics with `[SENSe:]CORRection:ENR:CALibration:TYPE`.

Parameters:

<Temperature> Temperature in degrees Kelvin.
*RST: 77 K

Example: CORR:ENR:CAL:TYPE RES
CORR:ENR:CAL:SPOT:COLD 100
Defines a cold temperature of 100 K.

Manual operation: See "Calibration" on page 51

[SENSe:]CORRection:ENR:CALibration:SPOT:HOT <Temperature>

This command defines a constant temperature of a resistor supplied with power (T_{hot}) used during calibration.

The command is available when you have selected a noise source with resistor characteristics with [SENSe:]CORRection:ENR:CALibration:TYPE.

Parameters:
<Temperature> Temperature in degrees Kelvin.
*RST: 77 K

Example: CORR:ENR:TYPE RES
CORR:ENR:CAL:SPOT:HOT 300
Defines a cold temperature of 300 K.

Manual operation: See "Calibration" on page 51

[SENSe:]CORRection:ENR:CALibration:MODE <Mode>

This command selects the ENR mode for the calibration.

This command is available when you use different noise sources for calibration and measurement ([SENSe:]CORRection:ENR:COMMon OFF).

Parameters:
<Mode> **SPOT**
Uses a constant ENR value for all measurement points (see [SENSe:]CORRection:ENR:CALibration:SPOT).

TABLe
Uses the contents of the ENR table.

*RST: SPOT

Example: CORR:ENR:CAL:MODE SPOT
Uses a constant ENR value for all measurement points.

Manual operation: See "Calibration" on page 51

[SENSe:]CORRection:ENR:CALibration:SPOT <ENR>

This command defines the constant ENR for all measurement points during calibration.

This command is available when you use different noise sources for calibration and measurement ([SENSe:]CORRection:ENR:COMMon OFF).

Parameters:

<ENR> Range: -999.99 to 999.99
*RST: 15
Default unit: dB

Example: `CORR:ENR:CAL:MODE SPOT`
`CORR:ENR:CAL:SPOT 30`
Selects constant ENR value mode and defines an ENR of 30 dB for all measurement points.

Manual operation: See "Calibration" on page 51

[SENSe:]CORRection:ENR:CALibration:TABLe:SELect <TableName>

This command selects an ENR or temperature table for calibration.

Note that the contents of the table are independent of whether you use it for calibration or the actual measurement. When you want to edit a table, regardless if you want to use it later for a measurement or for calibration, you have to use `[SENSe:]CORRection:ENR[:MEASurement]:TABLe:SELect`. This command only selects a table for calibration.

This command is available when you use different noise sources for calibration and measurement ([SENSe:]CORRection:ENR:COMMon OFF).

Parameters:

<TableName> String containing the table name.

Example: `CORR:ENR:MEAS:TABL:SEL 'ENRTable'`
Selects a table called 'ENRTable'.

Manual operation: See "Calibration" on page 51
See "New" on page 53
See "Edit" on page 53

[SENSe:]CORRection:ENR:CALibration:TYPE <Type>

This command selects the type of noise source you are using for the calibration.

Parameters:

<Type> **DIODe**
Selects a noise source with diode characteristics.

RESistor
Selects a noise source with resistor characteristics.
When you select this noise source type, the application automatically selects the manual measurement mode (see `[SENSe:]CONFigure:CONTrol`).

*RST: DIODe

Example: `CORR:ENR:CAL:TYPE RES`
Selects a noise source with resistor characteristics.

[SENSe:]CORRection:ENR:COMMon <State>

This command turns the use of a common ENR on or off.

For more information see "Common Noise Source" on page 51.

Parameters:

<State> ON | OFF

Example: `CORR:ENR:COMM ON`
Turns the use of a common ENR on.

Manual operation: See "Common Noise Source" on page 51

[SENSe:]CORRection:ENR[:MEASurement]:TABLe:DATA <Frequency>, <ENR>

This command defines the contents of the currently selected ENR table.

The ENR table should contain an ENR for all measurement points.

If you create a new table with this command, it will overwrite the current entries of the frequency list.

To select the ENR table you want to edit, use `[SENSe:]CORRection:ENR[:MEASurement]:TABLe:SELect`.

Parameters:

<Frequency>, <ENR> Each entry of the ENR table consists of one measurement point and the corresponding ENR.
The table can contain up to 500 entries.

<Frequency>
Frequency of the measurement point.
The range is from 0 Hz to 999.99 GHz.

<ENR>
ENR of the measurement point.
The range is from -999.99 dB to 999.99 dB.

Example: `CORR:ENR:MEAS:TABL:DATA 1MHZ,10,2MHZ,12`
Defines a new ENR table with two measurement points.

Manual operation: See "New" on page 53
See "Edit" on page 53
See "Edit Table" on page 54

[SENSe:]CORRection:ENR[:MEASurement]:TABLe:DELete <TableName>

This command deletes an ENR table.

Parameters:

<TableName> String containing the name of the table.

Example: `CORR:ENR:MEAS:TABL:DEL 'ENRTable'`
Deletes the table with the name 'ENRTable'.

Usage: Event

Manual operation: See "Delete" on page 54

[SENSe:]CORRection:ENR[:MEASurement]:TABLe:LIST?

This command queries all ENR tables available in the application.

Return values:

<Tables> String containing the names of the tables as a comma separated list.

Example: `CORR:ENR:TABL:LIST`
would return, e.g.
`'Table1,Table2,Table3'`

Usage: Query only

[SENSe:]CORRection:ENR[:MEASurement]:TABLe:SELect <TableName>

This command selects an ENR or temperature table for the actual measurement.

When you want to edit a table, regardless if you want to use it later for a measurement or for calibration, you have to use this command. `[SENSe:]CORRection:ENR:CALibration:TABLe:SELect` only selects a table for calibration.

Parameters:

<TableName> String containing the table name.

Example: `CORR:ENR:MEAS:TABL:SEL 'ENRTable'`
Selects a table called 'ENRTable'.

Manual operation: See "Measurement" on page 51
See "New" on page 53
See "Edit" on page 53

[SENSe:]CORRection:ENR[:MEASurement]:TABLe:TEMPerature[:DATA]
<Frequency>, <Thot>, <Tcold>

This command defines the contents of the currently selected temperature table.

The temperature table should contain an two temperature values for all measurement points.

If you create a new table with this command, it will overwrite the current entries of the frequency list.

To select the temperature table you want to edit, use `[SENSe:]CORRection:ENR[:MEASurement]:TABLe:SELect`.

Parameters:

<Frequency>, <Thot>, <Tcold> — Each entry of the temperature table consists of one measurement point and the corresponding temperature values.
The table can contain up to 500 entries.

<Frequency>
Frequency of the measurement point.
The range is from 0 Hz to 999.99 GHz.

<Thot>
Temperature of the noise source when it is off for the corresponding measurement point.
The range is from 0 K to 100000 K.

<Thot>
Temperature of the noise source when it is on for the corresponding measurement point.
The range is from 0 K to 100000 K.

Example: `CORR:ENR:MEAS:TABL:TEMPDATA 1MHZ,10,100,2MHZ,12,150`
Defines a new temperature table with two measurement points.

Manual operation: See "New" on page 53
See "Edit" on page 53
See "Edit Table" on page 54

[SENSe:]CORRection:ENR[:MEASurement]:TABLe:TEMPerature:DELete <TableName>

This command deletes a temperature table.

Parameters:

<TableName> — String containing the name of the table.

Example: `CORR:ENR:MEAS:TABL:TEMP:DEL 'TemperatureTable'`
Deletes the table with the name 'TemperatureTable'.

Manual operation: See "Delete" on page 54

[SENSe:]CORRection:ENR[:MEASurement]:TABLe:TEMPerature:LIST?

This command queries all temperature tables available in the application.

Return values:

<Tables> — String containing the names of the tables as a comma separated list.

Example: `CORR:ENR:TABL:TEMP:LIST`
would return, e.g.
`'Table1,Table2,Table3'`

Usage: Query only

[SENSe:]CORRection:ENR[:MEASurement]:MODE <Mode>

This command selects the ENR mode for the actual measurement.

Parameters:

<Mode>

SPOT
Uses a constant ENR value for all measurement points (see `[SENSe:]CORRection:ENR[:MEASurement]:SPOT`).

TABLe
Uses the contents of the ENR table.

*RST: SPOT

Example:

```
CORR:ENR:MODE SPOT
```

Uses a constant ENR value for all measurement points.

Manual operation: See "Measurement" on page 51

[SENSe:]CORRection:ENR[:MEASurement]:SPOT <ENR>

This command defines the constant ENR for all measurement points during the actual measurement.

Parameters:

<ENR>

Range: -999.99 to 999.99
*RST: 15
Default unit: dB

Example:

```
CORR:ENR:MODE SPOT
CORR:ENR:SPOT 30
```

Selects constant ENR value mode and defines an ENR of 30 dB for all measurement points.

Manual operation: See "Measurement" on page 51

[SENSe:]CORRection:ENR[:MEASurement]:TYPE <Type>

This command selects the type of noise source you are using for the measurement.

Parameters:

<Type>

DIODe
Selects a noise source with diode characteristics.

RESistor
Selects a noise source with resistor characteristics.
When you select this noise source type, the application automatically selects the manual measurement mode (see `[SENSe:]CONFigure:CONTrol`).

*RST: DIODe

Example:

```
CORR:ENR:TYPE RES
```

Selects a noise source with resistor characteristics.

Manual operation: See "Noise Source" on page 53

[SENSe:]CORRection:ENR[:MEASurement]:SPOT:COLD <Temperature>

This command defines a constant temperature of a resistor not supplied with power (T_{cold}) used during measurements.

The command is available when you have selected a noise source with resistor characteristics with `[SENSe:]CORRection:ENR[:MEASurement]:TYPE`.

Parameters:

<Temperature> Temperature in degrees Kelvin.
*RST: 77 K

Example:
```
CORR:ENR:TYPE RES
CORR:ENR:SPOT:COLD 100
```
Defines a cold temperature of 100 K.

Manual operation: See "Measurement" on page 51

[SENSe:]CORRection:ENR[:MEASurement]:SPOT:HOT <Temperature>

This command defines a constant temperature of a resistor supplied with power (T_{hot}) used during measurements.

The command is available when you have selected a noise source with resistor characteristics with `[SENSe:]CORRection:ENR[:MEASurement]:TYPE`.

Parameters:

<Temperature> Temperature in degrees Kelvin.
*RST: 77 K

Example:
```
CORR:ENR:TYPE RES
CORR:ENR:SPOT:HOT 300
```
Defines a cold temperature of 300 K.

Manual operation: See "Measurement" on page 51

[SENSe:]CORRection:TEMPerature <Temperature>

This command defines the room temperature of the measurement environment. The temperature is taken into account when calculating noise results.

Parameters:

<Temperature> Range: 278.15 to 318.15
*RST: 293
Default unit: K

Example:
```
CORR:TEMP 291.50
```
Specifies a room temperature of 291.50 Kelvin (18.5 C).

Manual operation: See "Temperature" on page 52

7.10 Configuring Additional Loss

The following commands are necessary to define loss resulting from equipment in the measurement setup.

[SENSe:]CORRection:LOSS:INPut:MODE 120
[SENSe:]CORRection:LOSS:INPut:SPOT 120
[SENSe:]CORRection:LOSS:INPut:TABLe 121
[SENSe:]CORRection:LOSS:INPut:TABLe:DELete 121
[SENSe:]CORRection:LOSS:INPut:TABLe:SELect 121
[SENSe:]CORRection:LOSS:OUTPut:MODE 121
[SENSe:]CORRection:LOSS:OUTPut:SPOT 122
[SENSe:]CORRection:LOSS:OUTPut:TABLe 122
[SENSe:]CORRection:LOSS:OUTPut:TABLe:DELete 123
[SENSe:]CORRection:LOSS:OUTPut:TABLe:SELect 123

[SENSe:]CORRection:LOSS:INPut:MODE <Mode>

This command selects the input loss mode.

Parameters:

<Mode>

SPOT
Uses a constant input loss value for all measurement points (see `[SENSe:]CORRection:LOSS:INPut:SPOT` on page 120).

TABLe
Uses the contents of the input loss table.

*RST: SPOT

Example:
```
CORR:LOSS:INP:MODE SPOT
```
Selects constant input loss.

Manual operation: See "Input Loss" on page 56

[SENSe:]CORRection:LOSS:INPut:SPOT <Loss>

This command defines a constant input loss for all measurement points.

Parameters:

<Loss>

Range: -999.99 to 999.99
*RST: 0 dB
Default unit: dB

Example:
```
CORR:LOSS:INP:MODE SPOT
CORR:LOSS:INP:SPOT 10
```
Selects constant input loss mode and defines an input loss of 10 dB for all measurement points.

Manual operation: See "Input Loss" on page 56

[SENSe:]CORRection:LOSS:INPut:TABLe <Frequency>, <Loss>

This command defines the contents of the currently selected input loss table.

The table should contain an input loss for all measurement points.

If you create a new table with this command, it will overwrite the current entries of the loss table.

Parameters:

<Frequency>, <ENR> Each entry of the loss table consists of one measurement point and the corresponding loss.
The table can contain up to 500 entries.

<Frequency>
Frequency of the measurement point.
The range is from 0 Hz to 999.99 GHz.

<Loss>
Loss of the measurement point.
The range is from -999.99 dB to 999.99 dB.

Example: `CORR:LOSS:INP:TABL 1MHz,10,2MHz,12`
Defines a new input loss table with two measurement points.

Manual operation: See "Edit Table" on page 54
See "New" on page 57
See "Edit" on page 58

[SENSe:]CORRection:LOSS:INPut:TABLe:DELete <TableName>

This command deletes an input loss table.

Parameters:

<TableName> String containing the name of the table.

Example: `CORR:LOSS:INP:TABL:DEL 'InputLoss'`
Deletes the table with the name 'InputLoss'.

Manual operation: See "Delete" on page 58

[SENSe:]CORRection:LOSS:INPut:TABLe:SELect <TableName>

This command selects an input loss table.

Parameters:

<TableName> String containing the table name.

Example: `CORR:LOSS:INP:TABL:SEL 'InputLoss'`
Selects a table called 'InputLoss'.

Manual operation: See "Input Loss" on page 56

[SENSe:]CORRection:LOSS:OUTPut:MODE <Mode>

This command selects the output loss mode.

Parameters:

<Mode>

SPOT
Uses a constant output loss value for all measurement points (see [SENSe:]CORRection:LOSS:OUTPut:SPOT on page 122).

TABLe
Uses the contents of the output loss table.

*RST: SPOT

Example:
```
CORR:LOSS:OUTP:MODE SPOT
```
Selects constant output loss.

Manual operation: See "Output Loss" on page 56

[SENSe:]CORRection:LOSS:OUTPut:SPOT <Loss>

This command defines a constant output loss for all measurement points.

Parameters:

<Loss>

Range: -999.99 to 999.99
*RST: 0 dB
Default unit: dB

Example:
```
CORR:LOSS:OUTP:MODE SPOT
CORR:LOSS:OUTP:SPOT 10
```
Selects constant output loss mode and defines an output loss of 10 dB for all measurement points.

Manual operation: See "Output Loss" on page 56

[SENSe:]CORRection:LOSS:OUTPut:TABLe <Frequency>, <Loss>

This command defines the contents of the currently selected output loss table.

The table should contain an output loss for all measurement points.

If you create a new table with this command, it will overwrite the current entries of the frequency list.

Parameters:

<Frequency>, <ENR>

Each entry of the loss table consists of one measurement point and the corresponding loss.
The table can contain up to 500 entries.

<Frequency>
Frequency of the measurement point.
The range is from 0 Hz to 999.99 GHz.

<Loss>
Loss of the measurement point.
The range is from -999.99 dB to 999.99 dB.

Example:
```
CORR:LOSS:OUTP:TABL 1MHz,10,2MHz,12
```
Defines a new output loss table with two measurement points.

Manual operation: See "Edit Table" on page 54
See "New" on page 57
See "Edit" on page 58

[SENSe:]CORRection:LOSS:OUTPut:TABLe:DELete <TableName>

This command deletes an output loss table.

Parameters:
<TableName> String containing the name of the table.

Example: `CORR:LOSS:OUTP:TABL:DEL 'OutputLoss'`
Deletes the table with the name 'OutputLoss'.

Manual operation: See "Delete" on page 58

[SENSe:]CORRection:LOSS:OUTPut:TABLe:SELect <TableName>

This command selects an output loss table.

Parameters:
<TableName> String containing the table name.

Example: `CORR:LOSS:OUTP:TABL:SEL 'OutputLoss'`
Selects a table called 'OutputLoss'.

Manual operation: See "Output Loss" on page 56

7.11 Configuring the Analyzer

The following commands are necessary to configure the analyzer.

[SENSe:]CONFigure:CORRection 123
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel 124
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:AUTO 124
INPut:ATTenuation 124
INPut:GAIN[:VALue] 125
INPut:GAIN:STATe 125
[SENSe:]BANDwidth[:RESolution] 125
[SENSe:]CORRection[:STATe] 126
[SENSe:]SWEep:COUNt 126
[SENSe:]SWEep:TIME 126
SYSTem:CONFigure:DUT:GAIN 126
SYSTem:CONFigure:DUT:STIMe 127

[SENSe:]CONFigure:CORRection

This command configures the software to perform a calibration measurement.

If you initate a measurement with `INITiate<n>[:IMMediate]`, the software initates a calibration instead of the actual measurement.

Example: `CONF:CORR`
Configures to run calibration.
`INIT`
Initiates the calibration.

Usage: Event

Manual operation: See "2nd Stage Correction" on page 59
See "Calibrate" on page 68

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel <ReferenceLevel>

This command defines the reference level (for all traces, <t> is irrelevant).

Parameters:
<ReferenceLevel> Range: see datasheet
*RST: -30 dBm
Default unit: dBm

Example: `DISP:TRAC:Y:RLEV -60dBm`

Usage: SCPI confirmed

Manual operation: See "Ref Level" on page 60

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:AUTO <State>

This command turns automatic determination of the reference level on and off.

Parameters:
<State> ON | OFF

Example: `DISP:TRAC:Y:RLEV:AUTO ON`
Turns on automatic level detection.

Usage: SCPI confirmed

Manual operation: See "Ref Level" on page 60

INPut:ATTenuation <Attenuation>

This command defines the total attenuation for RF input.

If you set the attenuation manually, it is no longer coupled to the reference level, but the reference level is coupled to the attenuation. Thus, if the current reference level is not compatible with an attenuation that has been set manually, the command also adjusts the reference level.

Parameters:
<Attenuation> Range: see data sheet
Increment: 5 dB
*RST: 10 dB (AUTO is set to ON)

Example: `INP:ATT 30dB`
Defines a 30 dB attenuation and decouples the attenuation from the reference level.

Usage: SCPI confirmed

Manual operation: See "RF Attenuation" on page 61

INPut:GAIN[:VALue] <Gain>

This command selects the gain level if the preamplifier is activated (`INP:GAIN:STAT ON`, see `INPut:GAIN:STATe` on page 125).

The command requires the additional preamplifier hardware option.

Parameters:

<Gain> 15 dB | 30 dB
The availability of gain levels depends on the model of the R&S FSWP.
R&S FSWP8: 15dB and 30 dB
R&S FSWP26 or higher: 30 dB
*RST: OFF

Example: `INP:GAIN:VAL 30`
Switches on 30 dB preamplification.

Usage: SCPI confirmed

INPut:GAIN:STATe <State>

This command turns the preamplifier on and off. It requires the optional preamplifiier hardware.

Parameters:

<State> ON | OFF
*RST: OFF

Example: `INP:GAIN:STAT ON`
Switches on 30 dB preamplification.

Usage: SCPI confirmed

Manual operation: See "Preamplifier" on page 61

[SENSe:]BANDwidth[:RESolution] <Bandwidth>

This command defines the resolution bandwidth and decouples the resolution bandwidth from the span.

Example: `BAND 1 MHz`
Sets the resolution bandwidth to 1 MHz

Usage: SCPI confirmed

Manual operation: See "Resolution Bandwidth (RBW)" on page 59

[SENSe:]CORRection[:STATe] <State>

This command includes or excludes calibration data in the actual measurement.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CORR ON`

Includes calibration data in the measurement.

[SENSe:]SWEep:COUNt <Averages>

This command defines the number of measurements that are used to average the results.

Parameters:

<Averages> Number of measurements that are performed at a single frequency before average results are displayed.
If you set an average of 0 or 1, the application performs a single measurement at each frequency.

Range: 0 to 32767
*RST: 1

Example: `SWE:COUN 10`

The application averages 10 measurements before it displays the results.

Manual operation: See "Average" on page 59

[SENSe:]SWEep:TIME <Time>

This command defines the measurement time.

Parameters:

<Time> refer to data sheet

*RST: depends on current settings (determined automatically)

Example: `SWE:TIME 10s`

Usage: SCPI confirmed

Manual operation: See "Sweep Time" on page 59

SYSTem:CONFigure:DUT:GAIN <Gain>

This command defines the expected gain of the DUT.

The application uses the gain for automatic reference level detection.

Parameters:

<Gain> Range: 10 to 1000
*RST: 30
Default unit: dB

Example: `SYST:CONF:DUT:GAIN 25`
Defines gain of 25 dB.

Manual operation: See "Auto Level Range" on page 61

SYSTem:CONFigure:DUT:STIMe <SettlingTime>

This command defines the settling time of the noise source.

Parameters:

<SettlingTime> Range: 0 s to 20 s
*RST: 50 ms

Example: `SYST:CONF:DUT:STIM 1 s`
Defines a settling time of 1 second.

Manual operation: See "Settling Time" on page 59

7.12 Using the Uncertainty Calculator

The following commands are necessary to work with the measurement uncertainty calculator.

CALCulate:UNCertainty:COMMon ... 128
CALCulate:UNCertainty:DATA:FREQuency ... 128
CALCulate:UNCertainty:DATA:GAIN ... 128
CALCulate:UNCertainty:DATA:NOISe ... 129
CALCulate:UNCertainty:DATA:RESults ... 129
CALCulate:UNCertainty:ENR:CALibration:UNCertainty ... 129
CALCulate:UNCertainty:ENR:CALibration:UNCertainty:COLD ... 130
CALCulate:UNCertainty:ENR:CALibration:UNCertainty:HOT ... 130
CALCulate:UNCertainty:ENR:UNCertainty ... 130
CALCulate:UNCertainty:ENR:UNCertainty:COLD ... 131
CALCulate:UNCertainty:ENR:UNCertainty:HOT ... 131
CALCulate:UNCertainty:MATCh:DUT:IN:RL ... 131
CALCulate:UNCertainty:MATCh:DUT:IN:[VSWR] ... 131
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CALCulate:UNCertainty:MATCh:DUT:OUT:[VSWR] ... 132
CALCulate:UNCertainty:MATCh:PREamp:RL ... 132
CALCulate:UNCertainty:MATCh:PREamp[:VSWR] ... 132
CALCulate:UNCertainty:MATCh:SOURce:CALibration[:VSWR] ... 133
CALCulate:UNCertainty:MATCh:SOURce:CALibration:RL ... 133
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CALCulate:UNCertainty:PREamp:NOISe....134
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CALCulate:UNCertainty:SANalyzer:NOISe:UNCertainty?....135

CALCulate:UNCertainty:COMMon <State>

This command turns matching of the noise source characteristics used during calibration and measurement on and off.

This command is available when you use different noise sources for calibration and measurement ([SENSe:]CORRection:ENR:COMMon OFF).

Parameters:

<State> ON | OFF

*RST: unavailable

Example: `CALC:UNC:COMM ON`
Applies the values of the calibration noise source to those of the measurement noise source.

Manual operation: See "Common Source for Meas and Cal" on page 63

CALCulate:UNCertainty:DATA:FREQuency <Frequency>

This command defines the frequency for which the uncertainty should be calculated.

This command is available if you have turned automatic determination of the DUT characteristics off with `CALCulate:UNCertainty:DATA:RESults`.

Parameters:

<Frequency> Frequency of the DUT.

*RST: 1 GHz

Example: `CALC:UNC:DATA:FREQ 100MHZ`
Defines a frequency of 100 MHz.

Manual operation: See "Use Measurement Values" on page 64

CALCulate:UNCertainty:DATA:GAIN <Gain>

This command defines the gain of the DUT.

This command is available if you have turned automatic determination of the DUT characteristics off with `CALCulate:UNCertainty:DATA:RESults`.

Parameters:

<Gain> Gain of the DUT.

*RST: 0 dB

Example: `CALC:UNC:DATA:GAIN -5DB`
Defines a DUT gain of -5 dB.

Manual operation: See "Use Measurement Values" on page 64

CALCulate:UNCertainty:DATA:NOISe <NoiseLevel>

This command defines the noise level of the DUT.

This command is available if you have turned automatic determination of the DUT characteristics off with `CALCulate:UNCertainty:DATA:RESults`.

Parameters:

<NoiseLevel> Noise level of the DUT.

*RST: 0 dB

Example: `CALC:UNC:DATA:NOIS 10DB`
Defines a DUT noise level of 10 dB.

Manual operation: See "Use Measurement Values" on page 64

CALCulate:UNCertainty:DATA:RESults <State>

This command turns automatic determination of the DUT characteristics for the calculation of the uncertainty on and off.

Parameters:

<State>

ON
The application calculates the uncertainty with the DUT characteristics (noise figure, gain and frequency) resulting from the noise figure measurement.

OFF
The application calculates the uncertainty with the DUT characteristics (noise figure, gain and frequency) based on the values you have defined manually.

Example: `CALC:UNC:DATA:RES ON`
Includes the uncertainty in the results displays.

Manual operation: See "Use Measurement Values" on page 64

CALCulate:UNCertainty:ENR:CALibration:UNCertainty <Uncertainty>

This command defines the uncertainty of a calibration noise source.

This command is available when `[SENSe:]CORRection:ENR:COMMon` and `CALCulate:UNCertainty:COMMon` are off.

Parameters:

<Uncertainty> Uncertainty value of the noise source.
Refer to the data sheet of the noise source to determine its uncertainty.

*RST: 0.1 dB

Example: `CALC:UNC:ENR:CAL:UNC 0.05`
Defines an uncertainty of 0.05 dB.

Manual operation: See "ENR Uncert(ainty)" on page 63

CALCulate:UNCertainty:ENR:CALibration:UNCertainty:COLD <Uncertainty>

This command defines the uncertainty of a calibration noise source.

This command is available when `[SENSe:]CORRection:ENR:COMMon` and `CALCulate:UNCertainty:COMMon` are off.

Parameters:

<Uncertainty> Cold temperature uncertainty value of the noise source.
Refer to the data sheet of the noise source to determine its uncertainty.

*RST: 0 K

Example: `CALC:UNC:ENR:CAL:UNC:COLD 5 K`
Defines a low temperature uncertainty of 5 K.

Manual operation: See "Temperature Uncert(ainty)" on page 64

CALCulate:UNCertainty:ENR:CALibration:UNCertainty:HOT <Uncertainty>

This command defines the uncertainty of a calibration noise source.

This command is available when `[SENSe:]CORRection:ENR:COMMon` and `CALCulate:UNCertainty:COMMon` are off.

Parameters:

<Uncertainty> Hot temperature uncertainty value of the noise source.
Refer to the data sheet of the noise source to determine its uncertainty.

*RST: 0 K

Example: `CALC:UNC:ENR:CAL:UNC:COLD 5 K`
Defines a high temperature uncertainty of 5 K.

Manual operation: See "Temperature Uncert(ainty)" on page 64

CALCulate:UNCertainty:ENR:UNCertainty <Uncertainty>

This command defines the uncertainty of a noise source.

If the noise sources during calibration and measurement are different, the command defines the uncertainty of the measurement noise source.

Parameters:

<Uncertainty> Uncertainty value of the noise source.
Refer to the data sheet of the noise source to determine its uncertainty.

*RST: 0.1 dB

Example: `CALC:UNC:ENR:UNC 0.05`
Defines an uncertainty of 0.05 dB.

Manual operation: See "ENR Uncert(ainty)" on page 63

CALCulate:UNCertainty:ENR:UNCertainty:COLD <Uncertainty>

This command defines the uncertainty of a resistor.

If the noise sources during calibration and measurement are different, the command defines the uncertainty of the measurement noise source.

Parameters:

<Uncertainty> Cold temperature uncertainty value of the noise source.
Refer to the data sheet of the noise source to determine its uncertainty.

*RST: 0 K

Example: `CALC:UNC:ENR:UNC:COLD 10`
Defines an low temperature uncertainty of 10 K.

Manual operation: See "Temperature Uncert(ainty)" on page 64

CALCulate:UNCertainty:ENR:UNCertainty:HOT <Uncertainty>

This command defines the uncertainty of a resistor.

If the noise sources during calibration and measurement are different, the command defines the uncertainty of the measurement noise source.

Parameters:

<Uncertainty> Hot temperature uncertainty value of the noise source.
Refer to the data sheet of the noise source to determine its uncertainty.

*RST: 0 K

Example: `CALC:UNC:ENR:UNC:HOT 10`
Defines an high temperature uncertainty of 10 K.

Manual operation: See "Temperature Uncert(ainty)" on page 64

CALCulate:UNCertainty:MATCh:DUT:IN:RL <ReturnLoss>

This command defines the return loss at the DUT input.

Parameters:

<ReturnLoss> *RST: 50.0 dB

Example: `CALC:UNC:MATC:DUT:IN:RL 25DB`
Defines a return loss of 25 dB.

Manual operation: See "Input / Output Match" on page 64

CALCulate:UNCertainty:MATCh:DUT:IN:[VSWR] <VSWR>

This command defines the VSWR at the DUT input.

Parameters:
<VSWR> *RST: 1.0

Example: `CALC:UNC:MATC:DUT:IN 1.1`
Defines a VSWR of 1.1 at the DUT input.

Manual operation: See "Input / Output Match" on page 64

CALCulate:UNCertainty:MATCh:DUT:OUT:RL <ReturnLoss>

This command defines the returns loss at the DUT output.

Parameters:
<ReturnLoss> *RST: 50.0 dB

Example: `CALC:UNC:MATC:DUT:OUT:RL 40DB`
Defines a return loss of 40 dB at the DUT output.

Manual operation: See "Input / Output Match" on page 64

CALCulate:UNCertainty:MATCh:DUT:OUT:[VSWR] <VSWR>

This command defines the VSWR at the DUT output.

Parameters:
<VSWR> *RST: 1.0

Example: `CALC:UNC:MATC:DUT:OUT 2.0`
Defines a VSWR of 2.0 at the DUT output.

Manual operation: See "Input / Output Match" on page 64

CALCulate:UNCertainty:MATCh:PREamp:RL <ReturnLoss>

This command defines the return loss at the input of the preamplifier.

Parameters:
<ReturnLoss> *RST: 13.98 dB

Example: `CALC:UNC:MATC:PRE:RL 14.5DB`
Defines a return loss of 14.5 dB.

CALCulate:UNCertainty:MATCh:PREamp[:VSWR] <VSWR>

This command defines the VSWR at the input of the preamplifier.

The command is available if you have turned on the preamplifier with `CALCulate:UNCertainty:PREamp:STATe` on page 134.

Parameters:
<VSWR> *RST: 1.5

Example: `CALC:UNC:MATC:PRE 1.8`
Defines a VSWR of 1.8.

CALCulate:UNCertainty:MATCh:SOURce:CALibration[:VSWR] <VSWR>

This command defines the VSWR at the calibration noise source output.

This command is available when `[SENSe:]CORRection:ENR:COMMon` and `CALCulate:UNCertainty:COMMon` are off.

Parameters:
<VSWR> *RST: 1.15

Example: `CALC:UNC:MATC:SOUR:CAL 1.4`
Defines a VSWR of 1.4.

Manual operation: See "Output Match" on page 63

CALCulate:UNCertainty:MATCh:SOURce:CALibration:RL <ReturnLoss>

This command defines the return loss at the calibration noise source output.

This command is available when `[SENSe:]CORRection:ENR:COMMon` and `CALCulate:UNCertainty:COMMon` are off.

Parameters:
<ReturnLoss> *RST: 23.13 dB

Example: `CALC:UNC:MATC:SOUR:CAL:RL 20DB`
Defines a return loss of 20 dB.

Manual operation: See "Output Match" on page 63

CALCulate:UNCertainty:MATCh:SOURce:RL <ReturnLoss>

This command defines the return loss at the noise source output.

If the noise sources during calibration and measurement are different, the command defines the uncertainty of the measurement noise source.

Parameters:
<ReturnLoss> *RST: 23.13 dB

Example: `CALC:UNC:MATC:SOUR:RL 20DB`
Defines a return loss of 20 dB.

Manual operation: See "Output Match" on page 63

CALCulate:UNCertainty:MATCh:SOURce[:VSWR] <VSWR>

This command defines the VSWR at the noise source output.

If the noise sources during calibration and measurement are different, the command defines the uncertainty of the measurement noise source.

Parameters:
<VSWR> *RST: 1.15

Example: `CALC:UNC:MATC:SOUR 1.4`
Defines a VSWR of 1.4.

Manual operation: See "Output Match" on page 63

CALCulate:UNCertainty:PREamp:GAIN <Gain>

This command define the gain of an external preamplifier that may be part of the test setup.

Parameters:

<Gain> **Gain of the preamplifier.**
Refer to the data sheet of the preamplifier to determine its gain.
*RST: 20 dB

Example: `CALC:UNC:PRE:GAIN 15DB`
Defines a gain of 15 dB.

CALCulate:UNCertainty:PREamp:NOISe <NoiseLevel>

This command defines the noise level of an external preamplifier that may be part of the test setup.

Parameters:

<NoiseLevel> Noise level of the preamplifier.
Refer to the data sheet of the preamplfier to determine its noise level.
*RST: 5 dB

Example: `CALC:UNC:PRE:NOIS 10DB`
Defines a noise level of 10 dB.

CALCulate:UNCertainty:PREamp:STATe <State>

This command includes or excludes an external preamplifier from the uncertainty calculation.

If the test setup uses an external preamplifier, you also have to define its noise figure and gain values.

Parameters:

<State> ON | OFF
*RST: OFF

Example: `CALC:UNC:PRE:STAT ON`
Turns the preamplifier on.

CALCulate:UNCertainty[:RESult]?

This command queries the uncertainty of noise figure results.

Return values:
<Uncertainty> Measurement uncertainty in dB.

Example: `CALC:UNC?`
Queries the uncertainty.

Usage: Query only

CALCulate:UNCertainty:SANalyzer:GAIN:UNCertainty?

This command queries the uncertainty value of the spectrum analyzer's internal gain.

Return values:
<Uncertainty> Gain uncertainty of the spectrum analyzer in dB.

Example: `CALC:UNC:SAN:GAIN:UNC?`
Queries the gain uncertainty.

Usage: Query only

CALCulate:UNCertainty:SANalyzer:NOISe:UNCertainty?

This command queries the uncertainty value of the spectrum analyzer's internal noise.

Return values:
<Uncertainty> Noise figure uncertainty of the spectrum analyzer in dB.

Example: `CALC:UNC:SAN:NOIS:UNC?`
Queries the noise figure uncertainty.

Usage: Query only

7.13 Performing Measurements

The following commands are necessary to perform noise figure measurements.

Example: perform calibration and subsequent single sweep measurement

```
//Perform calibration:
CONF:CORR
INIT;*OPC?
//Perform single sweep measurement and use 2nd stage correction:
CORR:STAT ON
CONF:LIST:SING
INIT
```

You can also perform a sequence of measurements using the Sequencer (see "Multiple Measurement Channels and Sequencer Function" on page 12).

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INITiate<n>:CONTinuous....137
INITiate<n>[:IMMediate]....137
INITiate<n>:SEQuencer:ABORt....138
INITiate<n>:SEQuencer:IMMediate....138
INITiate<n>:SEQuencer:MODE....138
[SENSe:]CONFigure:CONTrol....139
[SENSe:]CONFigure:MEASurement....139
SYSTem:SEQuencer....140

ABORt

This command aborts the measurement in the current measurement channel and resets the trigger system.

To prevent overlapping execution of the subsequent command before the measurement has been aborted successfully, use the `*OPC?` or `*WAI` command after `ABOR` and before the next command.

For details see the "Remote Basics" chapter in the R&S FSWP User Manual.

To abort a sequence of measurements by the Sequencer, use the `INITiate<n>:SEQuencer:ABORt` command.

Note on blocked remote control programs:

If a sequential command cannot be completed, for example because a triggered sweep never receives a trigger, the remote control program will never finish and the remote channel to the R&S FSWP is blocked for further commands. In this case, you must interrupt processing on the remote channel first in order to abort the measurement.

To do so, send a "Device Clear" command from the control instrument to the R&S FSWP on a parallel channel to clear all currently active remote channels. Depending on the used interface and protocol, send the following commands:

- **Visa**: `viClear()`
- **GPIB**: `ibclr()`
- **RSIB**: `RSDLLibclr()`

Now you can send the `ABORt` command on the remote channel performing the measurement.

Example: `ABOR;:INIT:IMM`
Aborts the current measurement and immediately starts a new one.

Example:
```
ABOR;*WAI
INIT:IMM
```
Aborts the current measurement and starts a new one once abortion has been completed.

Usage: Event
SCPI confirmed

INITiate<n>:CONTinuous <State>

This command controls the measurement mode for an individual measurement channel.

Note that in single measurement mode, you can synchronize to the end of the measurement with *OPC, *OPC? or *WAI. In continuous measurement mode, synchronization to the end of the measurement is not possible. Thus, it is not recommended that you use continuous measurement mode in remote control, as results like trace data or markers are only valid after a single measurement end synchronization.

For details on synchronization see the "Remote Basics" chapter in the R&S FSWP User Manual.

If the measurement mode is changed for a measurement channel while the Sequencer is active the mode is only considered the next time the measurement in that channel is activated by the Sequencer.

Suffix:
<n> irrelevant

Parameters:
<State> ON | OFF | 0 | 1

ON | 1
Continuous measurement

OFF | 0
Single measurement

*RST: 1

Example: `INIT:CONT OFF`
Switches the measurement mode to single measurement.
`INIT:CONT ON`
Switches the measurement mode to continuous measurement.

Manual operation: See "Continuous Sweep/RUN CONT" on page 67

INITiate<n>[:IMMediate]

This command starts a (single) new measurement.

You can synchronize to the end of the measurement with *OPC, *OPC? or *WAI.

Suffix:
<n> irrelevant

Usage: Event

Manual operation: See "Single Sweep/ RUN SINGLE" on page 68
See "Calibrate" on page 68

INITiate<n>:SEQuencer:ABORt

This command stops the currently active sequence of measurements. The Sequencer itself is not deactivated, so you can start a new sequence immediately using `INITiate<n>:SEQuencer:IMMediate` on page 138.

To deactivate the Sequencer use `SYSTem:SEQuencer` on page 140.

Suffix:
<n> irrelevant

Usage: Event

INITiate<n>:SEQuencer:IMMediate

This command starts a new sequence of measurements by the Sequencer.

Its effect is similar to the `INITiate<n>[:IMMediate]` command used for a single measurement.

Before this command can be executed, the Sequencer must be activated (see `SYSTem:SEQuencer` on page 140).

Suffix:
<n> irrelevant

Example:
```
SYST:SEQ ON
```
Activates the Sequencer.
```
INIT:SEQ:MODE SING
```
Sets single sequence mode so each active measurement will be performed once.
```
INIT:SEQ:IMM
```
Starts the sequential measurements.

Usage: Event

INITiate<n>:SEQuencer:MODE <Mode>

This command selects the way the R&S FSWP application performs measurements sequentially.

Before this command can be executed, the Sequencer must be activated (see `SYSTem:SEQuencer` on page 140).

A detailed programming example is provided in the "Operating Modes" chapter in the R&S FSWP User Manual.

Note: In order to synchronize to the end of a sequential measurement using *OPC, *OPC? or *WAI you must use `SINGle` Sequence mode.

For details on synchronization see the "Remote Basics" chapter in the R&S FSWP User Manual.

Suffix:
<n> irrelevant

Parameters:

<Mode>

SINGle
Each measurement is performed once (regardless of the channel's sweep mode), considering each channels' sweep count, until all measurements in all active channels have been performed.

CONTinuous
The measurements in each active channel are performed one after the other, repeatedly (regardless of the channel's sweep mode), in the same order, until the Sequencer is stopped.

CDEFined
First, a single sequence is performed. Then, only those channels in continuous sweep mode (`INIT:CONT ON`) are repeated.

*RST: CONTinuous

Example:

```
SYST:SEQ ON
```
Activates the Sequencer.
```
INIT:SEQ:MODE SING
```
Sets single sequence mode so each active measurement will be performed once.
```
INIT:SEQ:IMM
```
Starts the sequential measurements.

[SENSe:]CONFigure:CONTrol <Mode>

This command selects the measurement mode for the hot and cold power measurements.

Note that selecting a noise source with resistor characteristics with `[SENSe:]CORRection:ENR:CALibration:TYPE` or `[SENSe:]CORRection:ENR[:MEASurement]:TYPE` automatically selects manual measurement mode.

Parameters:

<Mode>

AUTO
Performs the Power (Hot) and Power (Cold) measurement in one step.

MANual
Performs the Power (Hot) and Power (Cold) measurement in two separate steps.

Example:

```
CONF:CONT AUTO
```
Selects the automatic measurement mode.

Manual operation: See "Meas Mode (Auto Manual)" on page 68

[SENSe:]CONFigure:MEASurement <Measurement>

This command selects the type of power measurement to perform next.

The command is available for manual measurements (see `[SENSe:]CONFigure:CONTrol`).

Parameters:

<Measurement>

COLD
Performs the Power (Cold) measurement next.

HOT
Performs the Power (Hot) measurement next.

Example:
```
CONF:CONT MAN
CONF:MEAS HOT
```
Performs the hot power measurement.

Manual operation: See "Meas Mode (Auto Manual)" on page 68

SYSTem:SEQuencer <State>

This command turns the Sequencer on and off. The Sequencer must be active before any other Sequencer commands (`INIT:SEQ...`) are executed, otherwise an error will occur.

A detailed programming example is provided in the "Operating Modes" chapter in the R&S FSWP User Manual.

Parameters:

<State>

ON | OFF | 0 | 1

ON | 1
The Sequencer is activated and a sequential measurement is started immediately.

OFF | 0
The Sequencer is deactivated. Any running sequential measurements are stopped. Further Sequencer commands (`INIT:SEQ...`) are not available.

*RST: 0

Example:
```
SYST:SEQ ON
```
Activates the Sequencer.
```
INIT:SEQ:MODE SING
```
Sets single Sequencer mode so each active measurement will be performed once.
```
INIT:SEQ:IMM
```
Starts the sequential measurements.
```
SYST:SEQ OFF
```

7.14 Configuring the Inputs and Outputs

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7.14.1 Radio Frequency (RF) Input

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INPut:IMPedance....141
INPut:FILTer:HPASs[:STATe]....141
INPut:FILTer:YIG[:STATe]....142

INPut:COUPling <CouplingType>

This command selects the coupling type of the RF input.

Parameters:

<CouplingType>
AC
AC coupling
DC
DC coupling
*RST: AC

Example: `INP:COUP DC`

Usage: SCPI confirmed

Manual operation: See "Input Coupling" on page 69

INPut:IMPedance <Impedance>

This command selects the nominal input impedance of the RF input. In some applications, only 50 Ω are supported.

75 Ω should be selected if the 50 Ω input impedance is transformed to a higher impedance using a matching pad of the RAZ type (= 25 Ω in series to the input impedance of the instrument). The power loss correction value in this case is 1.76 dB = 10 log (75Ω/50Ω).

Parameters:

<Impedance> 50 | 75
*RST: 50 Ω

Example: `INP:IMP 75`

Usage: SCPI confirmed

Manual operation: See "Impedance" on page 69

INPut:FILTer:HPASs[:STATe] <State>

Activates an additional internal high-pass filter for RF input signals from 1 GHz to 3 GHz. This filter is used to remove the harmonics of the R&S FSWP in order to measure the harmonics for a DUT, for example.

This function requires an additional high-pass filter hardware option.

(Note: for RF input signals outside the specified range, the high-pass filter has no effect. For signals with a frequency of approximately 4 GHz upwards, the harmonics are suppressed sufficiently by the YIG filter.)

Parameters:
<State> ON | OFF
*RST: OFF

Example: `INP:FILT:HPAS ON`
Turns on the filter.

Usage: SCPI confirmed

Manual operation: See "High-Pass Filter 1...3 GHz" on page 69

INPut:FILTer:YIG[:STATe] <State>

This command turns the YIG-preselector on and off.

Note the special conditions and restrictions for the YIG filter described in "YIG-Preselector" on page 70.

Parameters:
<State> ON | OFF | 0 | 1
*RST: OFF

Example: `INP:FILT:YIG OFF`
Deactivates the YIG-preselector.

Manual operation: See "YIG-Preselector" on page 70

7.14.2 External Generator

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SOURce:EXTernal:FREQuency[:FACTor]:DENominator <Denominator>
SOURce:EXTernal:FREQuency[:FACTor]:NUMerator <Numerator>
SOURce:EXTernal:FREQuency:OFFSet<offset> <Offset>

These commands define the frequency correction characteristics for the generator.

The commands are available with option R&S FSWP-B10.

Frequency correction is calculated according to the following equation:

$$f_{Generator} = \left[\left(f_{LO} + Offset\ <1> \right) * \frac{Numerator}{Denominator} \right] + Offset\ <2>$$

with:

- $f_{Generator}$= generator frequency
- f_{LO}= frequency of the analyzer's LO
- $f_{offset<1>}$= offset frequency of the analyzer
- $f_{offset<2>}$= offset frequency of other components

Suffix:
<offset> 1 | 2
offset frequencies as described above

Parameters:
<Denominator> Correction factor without a unit.
*RST: 1

<Numerator> Correction factor without a unit.
*RST: 1

<Offset> Frequency offset.
*RST: 0
Default unit: Hz

Example:
```
SOUR:EXT:FREQ:FACT:NOM 2
SOUR:EXT:FREQ:FACT:DEN 2.5
```
Defines a frequency correction factor of 2/2.5.
```
SOUR:EXT:FREQ:OFFS2 100HZ
```
Defines 100 Hz as the second frequency offset.

Manual operation: See "Frequency Coupling" on page 73

SOURce:EXTernal:POWer[:LEVel] <Level>

This command sets the output power of the selected generator.

Parameters:
<Level> <numeric value>
*RST: -20 dBm

Example:
```
SOUR:EXT:POW -30dBm
```
Sets the generator level to -30 dBm

Manual operation: See "Source Power" on page 73

SOURce:EXTernal:ROSCillator[:SOURce] <Source>

This command controls selection of the reference oscillator for the external generator.

If the external reference oscillator is selected, the reference signal must be connected to the rear panel of the instrument.

Parameters:

<Source>
INTernal
the internal reference is used
EXTernal
the external reference is used; if none is available, an error flag is displayed in the status bar
*RST: INT

Example:
```
SOUR:EXT:ROSC EXT
```
Switches to external reference oscillator

Manual operation: See "Reference" on page 71

SYSTem:COMMunicate:GPIB:RDEVice:GENerator:ADDRess <Number>

Changes the IEC/IEEE-bus address of the external generator.

Parameters:

<Number>
Range: 0 to 30
*RST: 28

Example:
```
SYST:COMM:GPIB:RDEV:GEN:ADDR 15
```

Manual operation: See "GPIB Address / TCP/IP Address" on page 71

SYSTem:COMMunicate:RDEVice:GENerator:INTerface <Type>

Defines the interface used for the connection to the external generator.

Parameters:

<Type>
GPIB | TCPip
*RST: GPIB

Example:
```
SYST:COMM:RDEV:GEN:INT TCP
```

Manual operation: See "Interface" on page 70

SYSTem:COMMunicate:RDEVice:GENerator:TYPE <Type>

This command selects the type of external generator.

Parameters:

<Name>
<Generator name as string value>
*RST: SMU02

Example:
```
SYST:COMM:RDEV:GEN:TYPE 'SMW06'
```
Selects SMW06 as an external generator

Manual operation: See "Generator Type" on page 70

SYSTem:COMMunicate:TCPip:RDEVice:GENerator:ADDRess <Address>

Configures the TCP/IP address for the external generator.

Parameters:
<Address> TCP/IP address between 0.0.0.0 and 0.255.255.255
*RST: 0.0.0.0

Example: `SYST:COMM:TCP:RDEV:GEN:ADDR 130.094.122.195`

Manual operation: See "GPIB Address / TCP/IP Address" on page 71

SYSTem:CONFigure:GENerator:CONTrol:STATe <State>

This command turns automatic control of an external generator on and off.

The command is available with option R&S FSWP-B10.

Parameters:
<State> ON | OFF
*RST: OFF

Example: `SYST:CONF:GEN:CONT:STAT ON`
Turns on automatic generator control.

Manual operation: See "Automatic Control" on page 72

SYSTem:CONFigure:GENerator:INITialise:AUTO <State>

This command turns automatic connection to the generator on and off.

If on, the application automatically configures the generator before each measurement and turns on its RF output. Note that you have to establish a connection to the generator before you can perform the measurement.

The command is available with option R&S FSWP-B10.

Parameters:
<State> ON | OFF
*RST: OFF

Example: `SYST:CONF:GEN:INIT:AUTO ON`
Turns automatic generator configuration on.

Manual operation: See "Init Before Meas" on page 72

SYSTem:CONFigure:GENerator:INITialise:IMMediate

This command establishes a connection to the external generator.

When you send the command, the application configures the generator once and turns on its RF output. Note that you have to establish a connection to the generator before you can perform the measurement.

The command is available with option R&S FSWP-B10.

Usage: Event

Manual operation: See "Init External Generator" on page 74

SYSTem:CONFigure:GENerator:SWITch:AUTO <State>

This command turns automatic deactivation of the generator's RF output after a measurement is done on and off.

The command is available with option R&S FSWP-B10.

Parameters:
<State> ON | OFF
*RST: OFF

Example: `SYST:CONF:GEN:SWIT:AUTO ON`
Turns on automatic deactivation of the RF output.

Manual operation: See "Auto Switch Off" on page 73

7.15 Configuring the Display

The following commands are necessary to configure and scale the result displays.

DISPlay[:WINDow<n>]:TRACe:SYMBols....146
DISPlay[:WINDow<n>]:TRACe:X[:SCALe]....147
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:BOTTom....147
DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:AUTO....147
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:TOP....148

DISPlay[:WINDow<n>]:TRACe:SYMBols <State>

This command turns symbols that represent the measurement points on a trace on and off.

Parameters:
<State> ON | OFF
*RST: OFF

Example: `DISP:WIND2:TRAC:SYMB ON`
Switches on the display of symbols in window 2..

Manual operation: See "Symbols" on page 76

DISPlay[:WINDow<n>]:TRACe:X[:SCALe] <Frequency>

This command selects the type of frequency displayed on the x-axis.

Parameters:

<Frequency>

IF
Intermediary frequency, e.g. for measurements on frequency converting DUTs.

RF
Radio frequency.

*RST: RF

Example:
```
CONF:MODE:DUT DOWN
```
The DUT converts the input frequency to a lower output frequency.
```
DISP:TRAC:X RF
```
Shows the RF frequency on the x-axis.

Manual operation: See "X-Axis" on page 76

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:BOTTom <Level>

This command defines the bottom value of the y-axis.

Parameters:

<Level>

The value ranges depend on the result display.

Noise figure
-75 dB to 75 dB

Noise temperature
-999990000 K to 999990000 K

Y-factor
-200 dB to 200 dB

Gain
-75 dB to 75 dB

Power (hot)
-200 dBm to 200 dBm

Power (cold)
-200 dBm to 200 dBm

Example:
```
DISP:WIND2:TRAC:Y:SCAL:AUTO OFF
DISP:WIND2:TRAC:Y:BOTT
```

Usage: SCPI confirmed

Manual operation: See "Auto Scale / Min / Max" on page 76

DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:AUTO <State>

This command turns automatic scaling of the y-axis on and off.

Parameters:

<State> ON | OFF

*RST: ON

Example: `DISP:WIND2:TRAC:Y:AUTO ON`
Turns on automatic scaling for measurement window 2.

Usage: SCPI confirmed

Manual operation: See "Auto Scale / Min / Max" on page 76

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:TOP <Level>

This command defines the top value of the y-axis.

Parameters:

<Level> The value ranges depend on the result display.

Noise figure
-75 dB to 75 dB

Noise temperature
-999990000 K to 999990000 K

Y-factor
-200 dB to 200 dB

Gain
-75 dB to 75 dB

Power (hot)
-200 dBm to 200 dBm

Power (cold)
-200 dBm to 200 dBm

Example:
```
DISP:WIND2:TRAC:Y:SCAL:AUTO OFF
DISP:WIND2:TRAC:Y:TOP
```

Usage: SCPI confirmed

Manual operation: See "Auto Scale / Min / Max" on page 76

7.16 Working with Traces

The following commands are necessary to define trace characteristics.

DISPlay[:WINDow<n>]:TRACe<t>:MODE....149
DISPlay[:WINDow<n>]:TRACe<t>[:STATe]....149
FORMat[:DATA]....149
FORMat:DEXPort:DSEParator....150
FORMat:DEXPort:HEADer....150
FORMat:DEXPort:TRACes....151
MMEMory:STORe<n>:TRACe....151
TRACe<n>:COPY....151

DISPlay[:WINDow<n>]:TRACe<t>:MODE <Mode>

This command selects the trace mode.

Parameters:

<Mode> BLANk | VIEW | WRITe

*RST: Trace 1: WRITe, Trace 2-4: BLANk

Example:

```
INIT:CONT OFF
```

Switching to single sweep mode.

```
SWE:COUN 16
```

Sets the number of measurements to 16.

```
DISP:TRAC3:MODE WRIT
```

Selects clear/write mode for trace 3.

```
INIT;*WAI
```

Starts the measurement and waits for the end of the measurement.

Manual operation: See "Traces" on page 78

DISPlay[:WINDow<n>]:TRACe<t>[:STATe] <State>

This command turns a trace on and off.

The measurement continues in the background.

Parameters:

<State> ON | OFF | 0 | 1

*RST: Trace 1: 1, Trace 2-4: 0

Example:

```
DISP:TRAC3 ON
```

Usage: SCPI confirmed

FORMat[:DATA] <Format>

This command selects the data format that is used for transmission of trace data from the R&S FSWP to the controlling computer.

Note that the command has no effect for data that you send to the R&S FSWP. The R&S FSWP automatically recognizes the data it receives, regardless of the format.

Parameters:

<Format>

ASCii
ASCii format, separated by commas.
This format is almost always suitable, regardless of the actual data format. However, the data is not as compact as other formats may be.

REAL,32
32-bit IEEE 754 floating-point numbers in the "definite length block format".
The format setting `REAL` is used for the binary transmission of trace data.
For I/Q data, 8 bytes per sample are returned for this format setting.

*RST: ASCII

Example: `FORM REAL,32`

Usage: SCPI confirmed

FORMat:DEXPort:DSEParator <Separator>

This command selects the decimal separator for data exported in ASCII format.

Parameters:

<Separator>

COMMa
Uses a comma as decimal separator, e.g. *4,05*.

POINt
Uses a point as decimal separator, e.g. *4.05*.

*RST: *RST has no effect on the decimal separator. Default is POINt.

Example: `FORM:DEXP:DSEP POIN`
Sets the decimal point as separator.

Manual operation: See "Trace Export" on page 78

FORMat:DEXPort:HEADer <State>

If enabled, additional instrument and measurement settings are included in the header of the export file for result data. If disabled, only the pure result data from the selected traces and tables is exported.

Parameters:

<State> ON | OFF | 0 | 1

*RST: 1

Usage: SCPI confirmed

Manual operation: See "Trace Export" on page 78

FORMat:DEXPort:TRACes <Selection>

This command selects the data to be included in a data export file (see `MMEMory:STORe<n>:TRACe` on page 151).

Parameters:

<Selection>

SINGle
Only a single trace is selected for export, namely the one specified by the `MMEMory:STORe<n>:TRACe` command.

ALL
Selects all active traces and result tables (e.g. Result Summary, marker peak list etc.) in the current application for export to an ASCII file.
The <trace> parameter for the `MMEMory:STORe<n>:TRACe` command is ignored.

*RST: SINGle

Usage: SCPI confirmed

Manual operation: See "Trace Export" on page 78

MMEMory:STORe<n>:TRACe <Trace>, <FileName>

This command exports trace data from the specified window to an ASCII file.

Secure User Mode

In secure user mode, settings that are to be stored on the instrument are stored to volatile memory, which is restricted to 256 MB. Thus, a "Memory full" error may occur although the hard disk indicates that storage space is still available.

To store data permanently, select an external storage location such as a USB memory device.

For details see "Protecting Data Using the Secure User Mode" in the "Data Management" section of the R&S FSWP User Manual.

Parameters:

<Trace> Number of the trace to be stored

<FileName> String containing the path and name of the target file.

Example: `MMEM:STOR1:TRAC 3,'C:\TEST.ASC'`
Stores trace 3 from window 1 in the file `TEST.ASC`.

Usage: SCPI confirmed

Manual operation: See "Trace Export" on page 78

TRACe<n>:COPY <TraceNumber>, <TraceNumber>

This command copies data from one trace to another.

Parameters:

<TraceNumber>, <TraceNumber>
TRACE1 | TRACE2 | TRACE3 | TRACE4
The first parameter is the destination trace, the second parameter is the source.
(Note the 'e' in the parameter is required!)

Example:
`TRAC:COPY TRACE1,TRACE2`
Copies the data from trace 2 to trace 1.

Usage:
SCPI confirmed

Manual operation:
See "Copy Trace" on page 78

7.17 Working with Limit Lines

The following commands are necessary to set up limit lines and checks.

When configuring limit lines for the noise figure application via remote control, you have to send some commands in a defined order.

1. Select the limit line you want to configure by name or create a new limit line name.
2. Select the result type you want to apply the limit line to.

   The application automatically selects the unit and scale to make the line compatible to the result type.
3. Define the horizontal data points of the limit line.
4. Define the vertical data points of the limit line. Depending on the command syntax you are using, the shape also defines if the limit line is an upper or lower limit line (`CALCulate:LIMit:UPPer:...` or `CALCulate:LIMit:LOWer:...`).

Example: Configure an upper limit line for the Noise Figure result type

```
//Select or create the limit line by name.
CALC:LIM:NAME 'NoiseFigure'
//Comment on the limit line.
CALC:LIM:COMM 'Limit line to test noise figure results'
//Select the result type (here: Noise Figure) to apply the limit line to.
CALC:LIM:TYPE NOIS
//Define the horizontal data points of the limit line.
CALC:LIM:CONT 100MHZ,850MHZ
//Shift the limit line 50 MHz to the left.
CALC:LIM:CONT:SHIF -50MHZ
//Define the vertical data points of an (upper) limit line.
//The unit is fix according to the result type you have selected.
CALC:LIM:UPP 10,10
//Shift the limit line 5 dB down.
CALC:LIM:UPP:SHIF -5
//Turn the limit line on.
CALC:LIM:UPP:STAT ON
```

```
//Select the trace to check.
CALC:LIM:TRAC 1
//Turn on the limit check.
CALC:LIM:STAT ON
//Query the limit check results.
CALC:LIM:FAIL?
```


- Defining General Characteristics of a Limit Line 153
- Defining Horizontal Data Points 154
- Controlling Lower Limit Lines 155
- Controlling Upper Limit Lines 156
- Managing Limit Lines 157
- Controlling Limit Checks 158

7.17.1 Defining General Characteristics of a Limit Line

CALCulate<n>:LIMit<k>:COMMent 153
CALCulate<n>:LIMit<k>:NAME 153
CALCulate:LIMit<k>:TYPE 153

CALCulate<n>:LIMit<k>:COMMent <Comment>

This command defines a comment for a limit line.

(<n> is irrelevant.)

Parameters:

<Comment> String containing the description of the limit line. The comment may have up to 40 characters.

Manual operation: See "Comment" on page 87

CALCulate<n>:LIMit<k>:NAME <Name>

This command selects a limit line that already exists or defines a name for a new limit line.

Parameters:

<Name> String containing the limit line name.

*RST: REM1 to REM8 for lines 1 to 8

Manual operation: See "Name" on page 87

CALCulate:LIMit<k>:TYPE <Result>

This command configures a limit line for a particular result type.

Parameters:

<Result>

GAIN
Assigns the limit line to gain reuslts.

NOISe
Assigns the limit line to noise figure results.

PCOLd
Assigns the limit line to power (cold) results.

PHOT
Assigns the limit line to power (hot) results.

TEMPerature
Assigns the limit line to noise temperature results.

YFACtor
Assigns the limit line to y-factor results.

Example:

```
CALC:LIM2:TYPE GAIN
```

Assigns limit line 2 to the gain result display.

7.17.2 Defining Horizontal Data Points

Note that the number of data points on the horizontal axis should be the same as the number of data points on the vertical axis. Otherwise the limit line may take on an unintended shape.

Example: Number of vertical data points < number of horizontal data points

```
CALC:LIM:CONT 100MHZ,200MHZ,300MHZ,400MHZ,500MHZ
CALC:LIM:UPP 0,5,0
```

⇒ the application dumps 400 and 500 MHz.

Example: Number of vertical data points > number of horizontal data points

```
CALC:LIM:CONT 100MHZ,200MHZ,300MHZ,400MHZ,500MHZ
CALC:LIM:UPP 0,5,0,5,0,5,0
```

⇒ the application adds new horizontal data points (500.00000100 MHz and 500.00000200 MHz).

CALCulate<n>:LIMit<k>:CONTrol[:DATA] 154
CALCulate<n>:LIMit<k>:CONTrol:SHIFt 155

CALCulate<n>:LIMit<k>:CONTrol[:DATA] <LimitLinePoints>

This command defines the horizontal definition points of a limit line.

(<n> is irrelevant.)

Parameters:

<LimitLinePoints> Variable number of x-axis values.
Note that the number of horizontal values has to be the same as the number of vertical values set with `CALCulate<n>:LIMit<k>:LOWer[:DATA]` or `CALCulate<n>:LIMit<k>:UPPer[:DATA]`. If not, the R&S FSWP either adds missing values or ignores surplus values.

*RST: -

Usage: SCPI confirmed

Manual operation: See "Data points" on page 88

CALCulate<n>:LIMit<k>:CONTrol:SHIFt <Distance>

This command moves a complete limit line horizontally.

Compared to defining an offset, this command actually changes the limit line definition points by the value you define.

(<n> is irrelevant.)

Parameters:

<Distance> Numeric value.
The unit depends on the scale of the x-axis.

Manual operation: See "Shift x" on page 88

7.17.3 Controlling Lower Limit Lines

CALCulate<n>:LIMit<k>:LOWer[:DATA] 155
CALCulate<n>:LIMit<k>:LOWer:SHIFt 156
CALCulate<n>:LIMit<k>:LOWer:STATe 156

CALCulate<n>:LIMit<k>:LOWer[:DATA] <LimitLinePoints>

This command defines the vertical definition points of a lower limit line.

(<n> is irrelevant.)

Parameters:

<LimitLinePoints> Variable number of level values.
Note that the number of vertical values has to be the same as the number of horizontal values set with `CALCulate<n>:LIMit<k>:CONTrol[:DATA]`. If not, the R&S FSWP either adds missing values or ignores surplus values.

*RST: Limit line state is OFF

Usage: SCPI confirmed

Manual operation: See "Data points" on page 88

CALCulate<n>:LIMit<k>:LOWer:SHIFt <Distance>

This command moves a complete lower limit line vertically.

Compared to defining an offset, this command actually changes the limit line definition points by the value you define.

Parameters:

<Distance> Defines the distance that the limit line moves.

Manual operation: See "Shift y" on page 88

CALCulate<n>:LIMit<k>:LOWer:STATe <State>

This command turns a lower limit line on and off.

Before you can use the command, you have to select a limit line with `CALCulate<n>:LIMit<k>:NAME` on page 153.

(<n> is irrelevant.)

Parameters:

<State> ON | OFF

*RST: OFF

Usage: SCPI confirmed

Manual operation: See "Visibility" on page 86

7.17.4 Controlling Upper Limit Lines

CALCulate<n>:LIMit<k>:UPPer[:DATA] 156
CALCulate<n>:LIMit<k>:UPPer:SHIFt 157
CALCulate<n>:LIMit<k>:UPPer:STATe 157

CALCulate<n>:LIMit<k>:UPPer[:DATA] <LimitLinePoints>

This command defines the vertical definition points of an upper limit line.

(<n> is irrelevant.)

Parameters:

<LimitLinePoints> Variable number of level values.
Note that the number of vertical values has to be the same as the number of horizontal values set with `CALCulate<n>:LIMit<k>:CONTrol[:DATA]`. If not, the R&S FSWP either adds missing values or ignores surplus values.

*RST: Limit line state is OFF

Usage: SCPI confirmed

Manual operation: See "Data points" on page 88

CALCulate<n>:LIMit<k>:UPPer:SHIFt <Distance>

This command moves a complete upper limit line vertically.

Compared to defining an offset, this command actually changes the limit line definition points by the value you define.

(<n> is irrelevant.)

Parameters:

<Distance> Defines the distance that the limit line moves.

Usage: Event

Manual operation: See "Shift y" on page 88

CALCulate<n>:LIMit<k>:UPPer:STATe <State>

This command turns an upper limit line on and off.

Before you can use the command, you have to select a limit line with `CALCulate<n>:LIMit<k>:NAME` on page 153.

(<n> is irrelevant.)

Parameters:

<State> ON | OFF

*RST: OFF

Usage: SCPI confirmed

Manual operation: See "Visibility" on page 86

7.17.5 Managing Limit Lines

CALCulate<n>:LIMit<k>:ACTive? 157
CALCulate<n>:LIMit<k>:COPY 158
CALCulate<n>:LIMit<k>:DELete 158

CALCulate<n>:LIMit<k>:ACTive?

This command queries the names of *all* active limit lines (<n>, <k> are irrelevant).

Return values:

<LimitLines> String containing the names of all active limit lines in alphabetical order.

Example: `CALC:LIM:ACT?`
Queries the names of all active limit lines.

Usage: Query only

Manual operation: See "Visibility" on page 86

CALCulate<n>:LIMit<k>:COPY <Line>

This command copies a limit line.

Parameters:

<Line> **1 to 8**
number of the new limit line

<name>
String containing the name of the limit line.

Example: `CALC:LIM1:COPY 2`
Copies limit line 1 to line 2.
`CALC:LIM1:COPY 'FM2'`
Copies limit line 1 to a new line named FM2.

Manual operation: See "Copy Line" on page 86

CALCulate<n>:LIMit<k>:DELete

This command deletes a limit line.

Usage: Event

Manual operation: See "Delete Line" on page 86

7.17.6 Controlling Limit Checks

CALCulate<n>:LIMit<k>:CLEar[:IMMediate] 158
CALCulate<n>:LIMit<k>:FAIL? 158
CALCulate<n>:LIMit<k>:STATe 159
CALCulate<n>:LIMit<k>:TRACe 159
CALCulate<n>:LIMit<k>:TRACe<t>:CHECk 160

CALCulate<n>:LIMit<k>:CLEar[:IMMediate]

This command deletes the result of the current limit check.

The command works on *all* limit lines in *all* measurement windows at the same time (<n>, <k> are irrelevant).

Example: `CALC:LIM:CLE`
Deletes the result of the limit check.

Usage: SCPI confirmed

CALCulate<n>:LIMit<k>:FAIL?

This command queries the result of a limit check.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

Return values:

<Result> **0**
PASS
1
FAIL

Example: `INIT;*WAI`
Starts a new sweep and waits for its end.
`CALC:LIM3:FAIL?`
Queries the result of the check for limit line 3.

Usage: Query only
SCPI confirmed

CALCulate<n>:LIMit<k>:STATe <State>

This command turns the limit check for a specific limit line on and off.

To query the limit check result, use `CALCulate<n>:LIMit<k>:FAIL?`.

Note that a new command exists to activate the limit check and define the trace to be checked in one step (see `CALCulate<n>:LIMit<k>:TRACe<t>:CHECk` on page 160).

(<n> is irrelevant.)

Parameters:

<State> ON | OFF
*RST: OFF

Example: `CALC:LIM:STAT ON`
Switches on the limit check for limit line 1.

Usage: SCPI confirmed

Manual operation: See "Disable All Lines" on page 86

CALCulate<n>:LIMit<k>:TRACe <TraceNumber>

This command links a limit line to one or more traces.

Note that this command is maintained for compatibility reasons only. Limit lines no longer need to be assigned to a trace explicitely. The trace to be checked can be defined directly (as a suffix) in the new command to activate the limit check (see `CALCulate<n>:LIMit<k>:TRACe<t>:CHECk` on page 160).

Parameters:

<TraceNumber> 1 to 4
*RST: 1

Example: `CALC:LIM2:TRAC 3`
Assigns limit line 2 to trace 3.

CALCulate<n>:LIMit<k>:TRACe<t>:CHECk <State>

This command turns the limit check for a specific trace on and off.

To query the limit check result, use `CALCulate<n>:LIMit<k>:FAIL?`.

Note that this command replaces the two commands from previous signal and spectrum analyzers (which are still supported, however):

- `CALCulate<n>:LIMit<k>:TRACe` on page 159
- `CALCulate<n>:LIMit<k>:STATe` on page 159

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:LIM3:TRAC2:CHEC ON`
Switches on the limit check for limit line 3 on trace 2.

Manual operation: See "Traces to be Checked" on page 86

7.18 Working with Markers

The following commands are necessary to work with markers.

- Using Markers....160
- Using Delta Markers....163
- Configuring Markers....165
- Positioning Markers....166
- Positioning Delta Markers....168

7.18.1 Using Markers

Note that the suffix at `CALCulate` has an effect only if you query the characteristics of a marker. If you set a marker, you can ignore the suffix because the markers are linked to each other over all measurement windows and will always be on the same frequency.

CALCulate<n>:MARKer<m>:AOFF....160
CALCulate<n>:MARKer<m>[:STATe]....161
CALCulate<n>:MARKer<m>:TRACe....161
CALCulate<n>:MARKer<m>:X....161
CALCulate<n>:MARKer<m>:Y?....162

CALCulate<n>:MARKer<m>:AOFF

This command turns all markers off.

Example: `CALC:MARK:AOFF`
Switches off all markers.

Usage: Event

Manual operation: See "All Markers Off" on page 81

CALCulate<n>:MARKer<m>[:STATe] <State>

This command turns markers on and off. If the corresponding marker number is currently active as a deltamarker, it is turned into a normal marker.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:MARK3 ON`
Switches on marker 3.

Manual operation: See "Marker Type" on page 81

CALCulate<n>:MARKer<m>:TRACe <Trace>

This command selects the trace the marker is positioned on.

Note that the corresponding trace must have a trace mode other than "Blank".

If necessary, the command activates the marker first.

Parameters:

<Trace> **1 to 4**
Trace number the marker is assigned to.

Example: `CALC:MARK3:TRAC 2`
Assigns marker 3 to trace 2.

CALCulate<n>:MARKer<m>:X <Position>

This command moves a marker to a particular coordinate on the x-axis.

If necessary, the command activates the marker.

If the marker has been used as a delta marker, the command turns it into a normal marker.

Note that markers have to be positioned on a discrete frequency that is part of the frequency list. If you set the marker on a frequency not included in the frequency list, the application positions the marker to the nearest frequency in the list (rounding up or down).

Parameters:

<Position> Numeric value that defines the marker position on the x-axis.
The unit is Hz.

Range: The range depends on the current x-axis range.

Example: `CALC:MARK2:X 1.7MHz`
Positions marker 2 to frequency 1.7 MHz.

CALCulate<n>:MARKer<m>:Y? <Result>

This command queries the position of a marker on the y-axis.

If necessary, the command activates the marker first.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

Parameters:

<Result> Selects the result.

CPCold
Queries calibration power (cold) results.

CPHot
Queries calibration power (hot) results.

CYFactor
Queries calibration y-factor results.

GAIN
Queries gain reuslts.

NOISe
Queries noise figure results.

NUNCertainty
Queries the noise figure uncertainty results.

PCOLd
Queries power (cold) results.

PHOT
Queries power (hot) results.

TEMPerature
Queries noise temperature results.

YFACtor
Queries y-factor results.

Return values:

<Result> Result at the marker position.

Example:

```
INIT:CONT OFF
```
Switches to single measurement mode.
```
CALC:MARK2 ON
```
Switches marker 2.
```
INIT;*WAI
```
Starts a measurement and waits for the end.
```
CALC:MARK2:Y?
```
Outputs the measured value of marker 2.

Usage: Query only

Manual operation: See "Marker Table" on page 22

7.18.2 Using Delta Markers

Note that the suffix at CALCulate has an effect only if you query the characteristics of a marker. If you set a marker, you can ignore the suffix because the markers are linked to each other over all measurement windows and will always be on the same frequency.

CALCulate<n>:DELTamarker<m>:AOFF 163
CALCulate<n>:DELTamarker<m>:MREF 163
CALCulate<n>:DELTamarker<m>[:STATe] 163
CALCulate<n>:DELTamarker<m>:TRACe 164
CALCulate<n>:DELTamarker<m>:X 164
CALCulate<n>:DELTamarker<m>:Y? 164

CALCulate<n>:DELTamarker<m>:AOFF

This command turns *all* delta markers off.

(<m> is irrelevant)

Example: CALC:DELT:AOFF
Turns all delta markers off.

Usage: Event

CALCulate<n>:DELTamarker<m>:MREF <Reference>

This command selects a reference marker for a delta marker other than marker 1.

The reference may be another marker or the fixed reference.

Parameters:

<Reference> **1 to 16**
Selects markers 1 to 16 as the reference.

FIXed
Selects the fixed reference as the reference.

Example: CALC:DELT3:MREF 2
Specifies that the values of delta marker 3 are relative to marker 2.

CALCulate<n>:DELTamarker<m>[:STATe] <State>

This command turns delta markers on and off.

If necessary, the command activates the delta marker first.

No suffix at DELTamarker turns on delta marker 1.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:DELT2 ON`
Turns on delta marker 2.

Manual operation: See "Marker Type" on page 81

CALCulate<n>:DELTamarker<m>:TRACe <Trace>

This command selects the trace a delta marker is positioned on.

Note that the corresponding trace must have a trace mode other than "Blank".

If necessary, the command activates the marker first.

Parameters:
<Trace> Trace number the marker is assigned to.

Example: `CALC:DELT2:TRAC 2`
Positions delta marker 2 on trace 2.

CALCulate<n>:DELTamarker<m>:X <Position>

This command moves a delta marker to a particular coordinate on the x-axis.

If necessary, the command activates the delta marker and positions a reference marker to the peak power.

Parameters:
<Position> Numeric value that defines the marker position on the x-axis.
Range: The value range and unit depend on the measurement and scale of the x-axis.

Example: `CALC:DELT:X?`
Outputs the absolute x-value of delta marker 1.

CALCulate<n>:DELTamarker<m>:Y? <Result>

This command queries the relative position of a delta marker on the y-axis.

If necessary, the command activates the delta marker first.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

The unit depends on the application of the command.

Parameters:

<Result> Selects the result.

CPCold
Queries calibration power (cold) results.

CPHot
Queries calibration power (hot) results.

CYFactor
Queries calibration y-factor results.

GAIN
Queries gain reuslts.

NOISe
Queries noise figure results.

PCOLd
Queries power (cold) results.

PHOT
Queries power (hot) results.

TEMPerature
Queries noise temperature results.

YFACtor
Queries y-factor results.

Return values:

<Position> Position of the delta marker in relation to the reference marker or the fixed reference.

Example:

```
INIT:CONT OFF
```
Switches to single sweep mode.
```
INIT;*WAI
```
Starts a sweep and waits for its end.
```
CALC:DELT2 ON
```
Switches on delta marker 2.
```
CALC:DELT2:Y?
```
Outputs measurement value of delta marker 2.

Usage: Query only

Manual operation: See "Marker Table" on page 22

7.18.3 Configuring Markers

DISPlay:MINFo[:STAT] 165
DISPlay:MTABle 166

DISPlay:MINFo[:STAT] <DisplayMode>

This command turns the marker information in all diagrams on and off.

Parameters:

<DisplayMode>

ON
Displays the marker information in the diagrams.

OFF
Hides the marker information in the diagrams.

*RST: ON

Example: `DISP:MINF OFF`
Hides the marker information.

Manual operation: See "Marker Info" on page 82

DISPlay:MTABle <DisplayMode>

This command turns the marker table on and off.

Parameters:

<DisplayMode>

ON
Turns the marker table on.

OFF
Turns the marker table off.

AUTO
Turns the marker table on if 3 or more markers are active.

*RST: AUTO

Example: `DISP:MTAB ON`
Activates the marker table.

Manual operation: See "Marker Table Display" on page 81

7.18.4 Positioning Markers

If you are using more than one window, the application performs the peak search in the window that you have selected with the suffix at `CALCulate` only. Because the markers are linked, the frequency position of the marker in the other windows is adjusted accordingly, even if it means that the marker is on a peak in the selected window only.

CALCulate<n>:MARKer<m>:MAXimum:LEFT 166
CALCulate<n>:MARKer<m>:MAXimum:NEXT 167
CALCulate<n>:MARKer<m>:MAXimum[:PEAK] 167
CALCulate<n>:MARKer<m>:MAXimum:RIGHt 167
CALCulate<n>:MARKer<m>:MINimum:NEXT 167
CALCulate<n>:MARKer<m>:MINimum:LEFT 167
CALCulate<n>:MARKer<m>:MINimum[:PEAK] 168
CALCulate<n>:MARKer<m>:MINimum:RIGHt 168

CALCulate<n>:MARKer<m>:MAXimum:LEFT

This command moves a marker to the next lower peak.

The search includes only measurement values to the left of the current marker position.

Usage: Event

Manual operation: See "Search Next Peak" on page 83

CALCulate<n>:MARKer<m>:MAXimum:NEXT

This command moves a marker to the next lower peak.

Usage: Event

Manual operation: See "Search Next Peak" on page 83

CALCulate<n>:MARKer<m>:MAXimum[:PEAK]

This command moves a marker to the highest level.

If the marker is not yet active, the command first activates the marker.

Usage: Event

Manual operation: See "Peak Search" on page 83

CALCulate<n>:MARKer<m>:MAXimum:RIGHt

This command moves a marker to the next lower peak.

The search includes only measurement values to the right of the current marker position.

Usage: Event

Manual operation: See "Search Next Peak" on page 83

CALCulate<n>:MARKer<m>:MINimum:NEXT

This command moves a marker to the next minimum value.

Usage: Event

Manual operation: See "Search Next Minimum" on page 84

CALCulate<n>:MARKer<m>:MINimum:LEFT

This command moves a marker to the next minimum value.

The search includes only measurement values to the right of the current marker position.

Usage: Event

Manual operation: See "Search Next Minimum" on page 84

CALCulate<n>:MARKer<m>:MINimum[:PEAK]

This command moves a marker to the minimum level.

If the marker is not yet active, the command first activates the marker.

Usage: Event

Manual operation: See "Search Minimum" on page 83

CALCulate<n>:MARKer<m>:MINimum:RIGHt

This command moves a marker to the next minimum value.

The search includes only measurement values to the right of the current marker position.

Usage: Event

Manual operation: See "Search Next Minimum" on page 84

7.18.5 Positioning Delta Markers

If you are using more than one window, the application performs the peak search in the window that you have selected with the suffix at `CALCulate` only. Because the markers are linked, the frequency position of the marker in the other windows is adjusted accordingly, even if it means that the marker is on a peak in the selected window only.

CALCulate<n>:DELTamarker<m>:MAXimum:LEFT 168
CALCulate<n>:DELTamarker<m>:MAXimum:NEXT 168
CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK] 169
CALCulate<n>:DELTamarker<m>:MAXimum:RIGHt 169
CALCulate<n>:DELTamarker<m>:MINimum:LEFT 169
CALCulate<n>:DELTamarker<m>:MINimum:NEXT 169
CALCulate<n>:DELTamarker<m>:MINimum[:PEAK] 169
CALCulate<n>:DELTamarker<m>:MINimum:RIGHt 170

CALCulate<n>:DELTamarker<m>:MAXimum:LEFT

This command moves a delta marker to the next higher value.

The search includes only measurement values to the left of the current marker position.

Usage: Event

Manual operation: See "Search Next Peak" on page 83

CALCulate<n>:DELTamarker<m>:MAXimum:NEXT

This command moves a marker to the next higher value.

Usage: Event

Manual operation: See "Search Next Peak" on page 83

CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]

This command moves a delta marker to the highest level.

If the marker is not yet active, the command first activates the marker.

Usage: Event

Manual operation: See "Peak Search" on page 83

CALCulate<n>:DELTamarker<m>:MAXimum:RIGHt

This command moves a delta marker to the next higher value.

The search includes only measurement values to the right of the current marker position.

Usage: Event

Manual operation: See "Search Next Peak" on page 83

CALCulate<n>:DELTamarker<m>:MINimum:LEFT

This command moves a delta marker to the next higher minimum value.

The search includes only measurement values to the right of the current marker position.

Usage: Event

Manual operation: See "Search Next Minimum" on page 84

CALCulate<n>:DELTamarker<m>:MINimum:NEXT

This command moves a marker to the next higher minimum value.

Usage: Event

Manual operation: See "Search Next Minimum" on page 84

CALCulate<n>:DELTamarker<m>:MINimum[:PEAK]

This command moves a delta marker to the minimum level.

If the marker is not yet active, the command first activates the marker.

Usage: Event

Manual operation: See "Search Minimum" on page 83

CALCulate<n>:DELTamarker<m>:MINimum:RIGHt

This command moves a delta marker to the next higher minimum value.

The search includes only measurement values to the right of the current marker position.

Usage: Event

Manual operation: See "Search Next Minimum" on page 84

7.19 Using the Status Register

The status reporting system stores information about the current state of the R&S FSWP. This includes, for example, information about errors during operation or information about limit checks. The R&S FSWP stores this information in the status registers and in the error queue. You can query the status register and error queue via IEC bus.

The R&S FSWP-K30 features several status registers that are specific to noise figure measurements. Here is a description of those, including the corresponding remote commands.

- Status Registers for Noise Figure Measurements..... 170

7.19.1 Status Registers for Noise Figure Measurements

The figure below shows the status registers of the noise figure application.

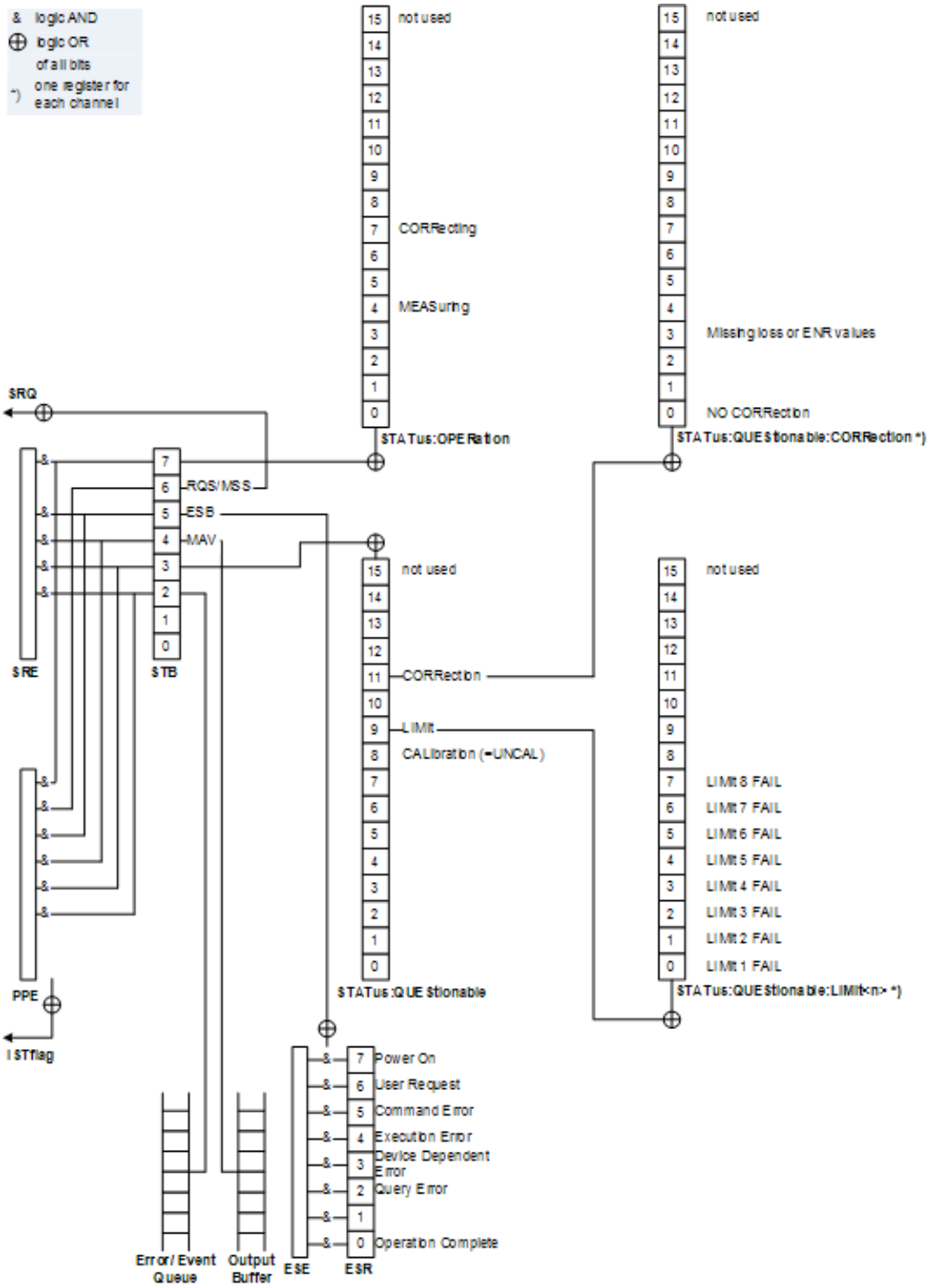

Fig. 7-2: Status registers for noise figure measurements

The R&S FSWP structures the information hierarchically, with the Status Byte register (STB) and the Service Request Enable mask register (SRE) being on the highest level. The STB gets its information from the standard Event Status Register (ESR) and the Event Status Enable mask register (ESE). The STB and ESR are both defined by IEEE 488.2. In addition to the ESR, the STB also gets information from the STATus:OPERation and STATus:QUEStionable registers. These are the link to the lower levels of the

status register and are defined by SCPI. They contain information about the state of the instrument.

For a more comprehensive description of the status registers not mentioned here and status register functionality in general see the manual of the base unit.

7.19.1.1 STATus:OPERation Register

The `STATus:OPERation` register contains information on current activities of the R&S FSWP. It also contains information on activities that have been executed since the last read out.

Bit no	Meaning
0 to 3	Unavailable for noise figure measurements.
4	MEASuring This bit is set if a measurement is in progress.
5 to 6	Unavailable for noise figure measurements.
7	CORRecting This bit is set if a 2nd stage correction is in progress.
8	HCOPy This bit is set if a hardcopy is created.
9 - 14	Unavailable for noise figure measurements.
15	This bit is always 0.

7.19.1.2 STATus:QUEStionable Register

The `STATus:QUEStionable` register contains information about indefinite states which may occur if the unit is operated without meeting the specifications.

Bit no	Meaning
0 to 7	Unavailable for noise figure measurements.
8	CALibration This bit is set if the R&S FSWP is not calibrated.
9	LIMit This bit is set if a limit line is violated.
10	Unavailable for noise figure measurements.
11	CORRection This bit is set if the noise figure calibration is questionable.
14	Unavailable for noise figure measurements.
15	This bit is always 0.

7.19.1.3 STATus:QUEStionable:LIMit Register

The `STATus:QUEStionable:LIMit` register contains information about limit lines and the results of a limit checks.

The number of LIMit registers depends on the number of measurement windows available in any application.

Bit no	Meaning
0	LIMit 1 FAIL This bit is set if limit line 1 is violated.
1	LIMit 2 FAIL This bit is set if limit line 2 is violated.
2	LIMit 3 FAIL This bit is set if limit line 3 is violated.
3	LIMit 4 FAIL This bit is set if limit line 4 is violated.
4	LIMit 5 FAIL This bit is set if limit line 5 is violated.
5	LIMit 6 FAIL This bit is set if limit line 6 is violated.
6	LIMit 7 FAIL This bit is set if limit line 7 is violated.
7	LIMit 8 FAIL This bit is set if limit line 8 is violated.
8 to 14	Unavailable for noise figure measurements.
15	This bit is always 0.

7.19.1.4 STATus:QUEStionable:CORRection Register

The `STATus:QUEStionable:CORRection` register contains information about the calibration status of noise figure measurements.

Bit no	Meaning
0	NO CORRection This bit is set if calibration is required.
1 to 2	Unavailable for noise figure measurements.
3	Missing Loss or ENR values This bit is set if loss or ENR values are missing for one or more measurement frequencies.

Bit no	Meaning
4 to 14	Unavailable for noise figure measurements.
15	This bit is always 0.

7.19.1.5 Status Register Remote Commands

STATus:OPERation[:EVENt]?....174
STATus:QUEStionable[:EVENt]?....174
STATus:QUEStionable:CORRection[:EVENt]?....174
STATus:QUEStionable:LIMit[:EVENt]?....174
STATus:OPERation:CONDition?....174
STATus:QUEStionable:CONDition?....174
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STATus:QUEStionable:PTRansition....175
STATus:QUEStionable:CORRection:PTRansition....175
STATus:QUEStionable:LIMit:PTRansition....175

STATus:OPERation[:EVENt]?
STATus:QUEStionable[:EVENt]?
STATus:QUEStionable:CORRection[:EVENt]? <ChannelName>
STATus:QUEStionable:LIMit[:EVENt]? <ChannelName>

These commands read out the EVENt section of the status register.

The commands at the same time delete the contents of the EVENt section.

Query parameters:

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

Usage: Query only

STATus:OPERation:CONDition?
STATus:QUEStionable:CONDition?
STATus:QUEStionable:CORRection:CONDition? <ChannelName>
STATus:QUEStionable:LIMit:CONDition? <ChannelName>

These commands read out the CONDition section of the status register.

The commands do not delete the contents of the EVENt section.

Query parameters:

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

Usage: Query only

STATus:OPERation:ENABle <SumBit>,<ChannelName>
STATus:QUEStionable:ENABle <SumBit>,<ChannelName>
STATus:QUEStionable:CORRection:ENABle <SumBit>,<ChannelName>
STATus:QUEStionable:LIMit:ENABle <SumBit>,<ChannelName>

These commands control the ENABle part of a register.

The ENABle part allows true conditions in the EVENt part of the status register to bereported in the summary bit. If a bit is 1 in the enable register and its associated event bit transitions to true, a positive transition will occur in the summary bit reported to the next higher level.

Parameters:

<SumBit> Range: 0 to 65535

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

STATus:OPERation:NTRansition <SumBit>,<ChannelName>
STATus:QUEStionable:NTRansition <SumBit>,<ChannelName>
STATus:QUEStionable:CORRection:NTRansition <SumBit>,<ChannelName>
STATus:QUEStionable:LIMit:NTRansition <SumBit>,<ChannelName>

These commands control the Negative TRansition part of a register.

Setting a bit causes a 1 to 0 transition in the corresponding bit of the associated register. The transition also writes a 1 into the associated bit of the corresponding EVENt register.

Parameters:

<SumBit> Range: 0 to 65535

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

STATus:OPERation:PTRansition <SumBit>,<ChannelName>
STATus:QUEStionable:PTRansition <SumBit>,<ChannelName>
STATus:QUEStionable:CORRection:PTRansition <SumBit>,<ChannelName>
STATus:QUEStionable:LIMit:PTRansition <SumBit>,<ChannelName>

These commands control the Positive TRansition part of a register.

Setting a bit causes a 0 to 1 transition in the corresponding bit of the associated register. The transition also writes a 1 into the associated bit of the corresponding EVENt register.

Parameters:

<SumBit> Range: 0 to 65535

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

7.20 Deprecated Remote Commands for Noise Figure Measurements

Following is a list of deprecated remote commands. The remote commands are still supported to maintain compatibility to previous versions of noise figure measurements (like the R&S FSV-K30), but it is strongly recommended to use the command system in the way it is meant to be used in the R&S FSWP-K30.

Legacy command	Replaced by	Comment
`CALCulate:LIMit:TRACe`	`CALCulate:LIMit:TYPE`	Parameters `NFIGure`, `TEFFective` and `GAIN` were supported to assign a limit line to a result and thus the trace because trace and result type were fix. `CALCulate:LIMit:TRACe` now assigns the limit line to a trace (1 to 4).
`CALCulate:MARKer:TRACe` `CALCulate:DELTamarker:TRACe`		The parameters `NOISe`, `GAIN`, `NMEM1-3` and `GMEM1-3` have been replaced by `1 | 2 | 3 | 4` because no distinction is made between memory and live trace.
`CONFigure:ARRay:MEMory`	`TRACe:COPY`	No more distinction between memory and live traces.
`CONFigure:SINGle`	`CONFigure:FREQuency:SINGle`	
`DISPlay:ARRay:MEMory:STATe` `DISPlay:CURRent:DATA:STATe`	`DISPlay:WINDow:TRACe:STATe`	No more distinction between memory and live traces.
`DISPlay:DATA:TRACe`	`LAYout` system	
`DISPlay:FORMat`	---	Functionality not supported any more.
`DISPlay:WINDow:TABLe`	`LAYout:WINDow:REPLace` / `LAYout:REPLace:WINDow`	
`FETCh:` command system	`TRACE:DATA`	
`SENSe:SWEep:POINts`	`SENSe:FREQuency:POINts`	
`SENSe:FREQuency:CW:FIXed`	`SENSe:FREQuency:SINGle`	

List of Remote Commands (Noise Figure)

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[SENSe:]CONFigure:CORRection....123
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[SENSe:]CONFigure:MODE:SYSTem:IF:FREQuency....111
[SENSe:]CONFigure:MODE:SYSTem:LO:FREQuency....111
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[SENSe:]CORRection:ENR:CALibration:SPOT....113
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<note> For upconverting measurements, if a <xref y.id="ID_b3f58cd4bd9811e49e7fb3229e1736e4" y.target.id="ID_f9983a6222fff9d20a00206a01aaeab8" y.io.id="31fc1fbcc9a2dd040a001ae7547c5ca6" y.io.version="8" y.io.language="en" y.io.variant="US" y.io.name="FPS_Preamplifier" y.linktype="any" y.link.required="true"><p.text><y.label/></p.text></xref> is used, make sure the upconverted frequencies for the measurement stay below the maximum frequency the preamplifier supports. </note>Configuration 40
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